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Iron and Steel Engineer

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T. B. LITTLE, EDITOR

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COMING MEETINGS AND PAPERS

▲

PHILADELPHIA SECTION

L. F. Coffin, Chairman — **L. O. Morrow, Secretary**

Engineers' Club, 1317 Spruce Street

Dinner 6:00 P. M. — **Meeting 7:00 P. M.**

February 2, 1935

"X-Ray Examination of Metallic Bodies," by N. L. Mochel, Metallurgical Engineer, Westinghouse Electric & Manufacturing Company, South Philadelphia Works, Philadelphia, Pa.

A special invitation to attend this meeting is extended to the members of the American Society for Metals.

CHICAGO SECTION

C. J. Smith, Chairman — **A. J. Whitcomb, Secretary**

Electric Association, 20 North Wacker Drive
Dinner 6:30 P. M.

February 5, 1935

"Electric Furnace Annealing and Normalizing of Sheet and Strip Steel," by A. N. Otis, Industrial Engineering Department, General Electric Company, Schenectady, N. Y.

PITTSBURGH SECTION

H. G. R. Bennett, Chairman — **C. H. Hunt, Secretary**

Cardinal Room, William Penn Hotel
Saturday, 7:30 P. M.

February 16, 1935

"Developments in Three-High Mills," by F. A. Beatty, Chief Engineer, Lewis Foundry and Machine Company, Groveton, Pa.

CLEVELAND SECTION

C. C. Wales, Chairman — **W. W. Spanagel, Secretary**

Cleveland Engineering Society Rooms

Dinner 6:15 P. M. — **Meeting 8:00 P. M.**

February 8, 1935

"Recent Applications of Roller Bearings to Continuous Strip Mills and Rod Mills," by S. M. Weckstein, Asst. Chief Engineer, Timken Roller Bearing Company, Canton, Ohio.

BIRMINGHAM SECTION

C. R. Tinsley, Chairman — **B. Thele, Secretary**

February Meeting.

Details and date will be announced later.

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Airplane View of Pittsburgh, Showing the Confluence of the Allegheny and Monongahela Rivers Which Form the Ohio.

PITTSBURGH—the city whose name has been made famous by steel—is the site chosen by the board of directors of the A. I. & S. E. E., at their regular meeting held January 12, for the 31st convention and iron and steel exposition. The dates for the annual meeting are September 24, 25, and 26. The William Penn Hotel was selected as the official headquarters and will house both the meetings and exposition. Centrally located as far as the steel industry is concerned this city has within a radius of 100 miles a producing capacity of approximately 34,192,000 tons of steel or about 50 per cent of the total capacity.

With such a large producing area as a nucleus for conducting a successful convention, plans are being rapidly formulated for both the technical sessions and the exposition. Layouts for the exposition space will be ready for disposition in February.

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The Development Of The Modern Blast Furnace

By ARTHUR G. McKEE
President, Arthur G. McKee & Company, Cleveland, Ohio.

Paper presented at the A. I. & S. E. E. Annual Convention held in Cleveland, Ohio, September 18, 19 and 20, 1934.

ARTHUR G. McKEE

I am not going to read a paper at all. I had an experience in Youngstown one time where I read a paper and it put most of them to sleep, so I swore off then and haven't written a paper since.

What I want to do this morning is to talk to you about blast furnace development and see whether we can perchance get to thinking a little bit more than we normally do. I am going to try and serve as a signboard. You know, a signboard is helpful even though it stands still. I am going to try and give you something to think about in the way of possible development in blast furnace construction. I was asked some six months ago if I wouldn't talk to you this morning and in a weak moment I said I would. Here we are and I hope among us we can get to something that is interesting.

The President of this Association, Mr. Walter H. Burr, in his annual message to the Association said, among other things, "We must advance. He who stops is overwhelmed. He who ceases to grow greater becomes smaller. He who leaves off gives up. The stationary condition is the beginning of the end." That is my text this morning, but this isn't going to be a sermon.

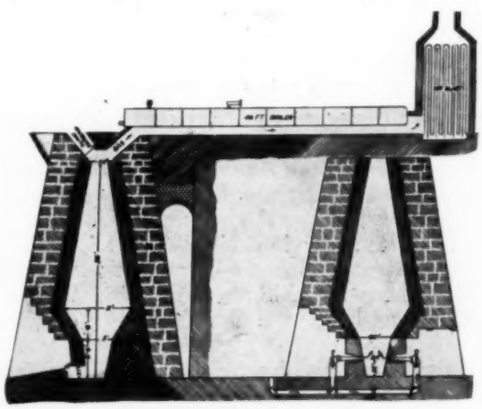


FIG. 1.

I was born up in the mountains at State College, Pennsylvania, and one of my earliest recollections is an old stone blast furnace. The one I speak of was a pyramid and still stands in the old place.

Fig. 1 shows two blast furnaces which are of about the same period as the one just mentioned. You will notice the hearth is two or three feet in diameter. The gas from the furnace passed first through the setting of the old cylindrical tubeless boiler and then through the old-fashioned pipe stove which is shown to the right. Due to the draft, enough air was pulled in through an opening to complete combustion. Of course, it is an outside fired boiler, having no tubes at all. They dumped the stock into the top and the distribution was not a matter of any great concern. It must have been a one-sided operation but that was the best they could do. These furnaces were built about 1853 and were the best they had at the time.

Two or three weeks ago I sent for our files and found a drawing of the original Perry Iron Company furnace at Erie, (Fig. 2) which was one of the first furnaces designed and built after I went into the business as an independent engineer in 1905. This furnace was at that time somewhat obsolete, but my old friends Ed. Williams and Sherman Clark insisted they wouldn't have that type of furnace because of the experience Williams had had in Toledo.

You will see this is a hand-filled furnace, open top, and during its operation was reasonably satisfactory, although the labor costs were high. That

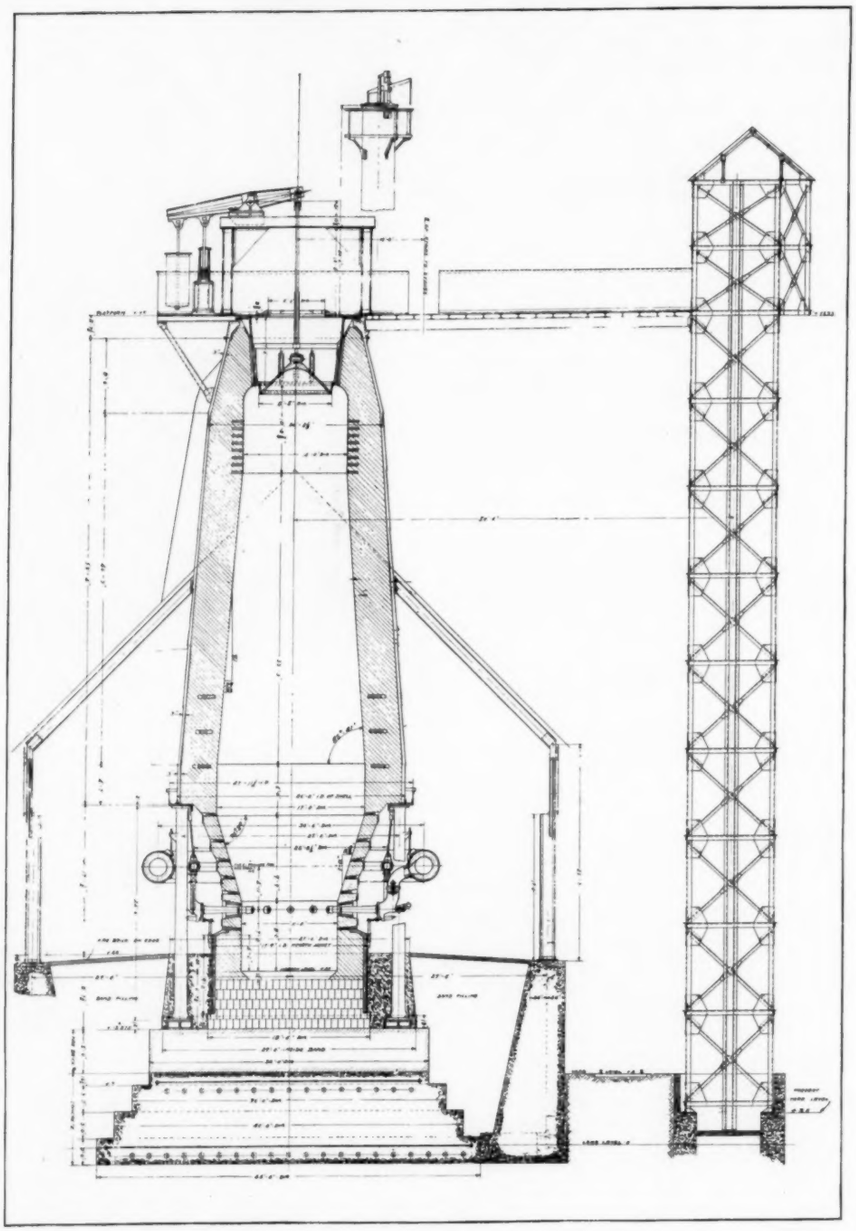


FIG. 2.

was one of the last vertical hoist furnaces built in this country.

Referring to the very excellent paper entitled "The Modern Blast Furnace" compiled by the Pig Iron and Coke Association of Chicago some three or four years ago, I have taken the liberty of copying some of the furnace sections given us (Fig. 3).

Section 1 is Edgar Thomson "B" furnace as lined in 1880. This is a small hearth furnace with a large top. It has an 11-foot hearth, 20-foot bosh, and 17-foot top. In Section 2 we see an Edgar Thomson furnace which was built in 1890. It had an 11-foot hearth, 22-foot bosh, and a 15′-6″ top. Then Section 3 which was built in 1901, Edgar Thomson, 14′-6″ hearth, 73°30′ angle, and 15-foot top. That was the development after twenty or twenty-five years of blast furnace design, and I must say this particular design was probably the worst that was ever built in this country. We thought at that time it was the best because it produced more iron than the others. With the low bosh it did, but it is hard to imagine a furnace which could raise cain more constantly and show more kinds of trouble than a furnace with a flat bosh like that.

I was in England twenty years ago and was talking with the manager of a blast furnace plant, and I told him something about the American development in blast furnace construction, about steep boshes, etc. He said, "In England your American furnaces don't work. I know they don't because I have two

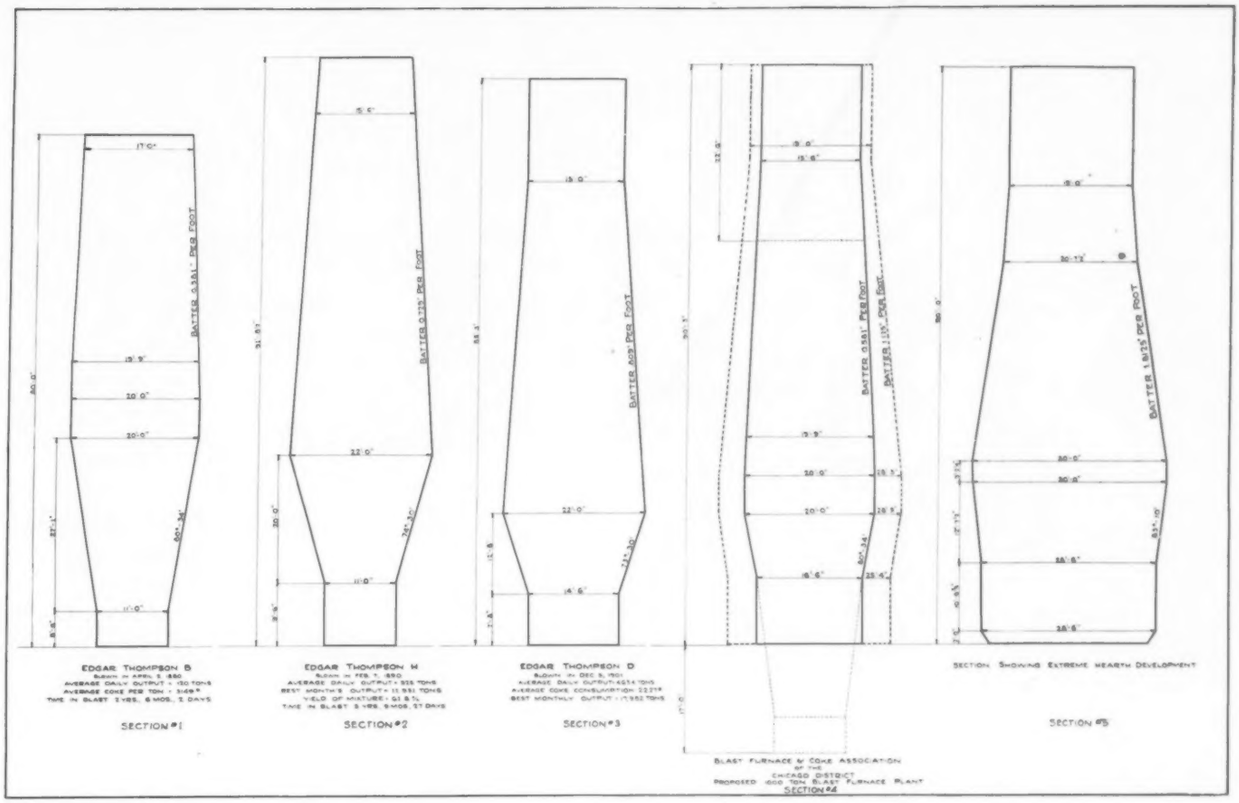


FIG. 3

of them here." I said to him, "Tell me, what are the lines of these furnaces?" He showed me the lines of the furnaces as built by Mr. Roberts. He said, "And I have improved them materially." The lines as built by Mr. Roberts had a 72° bosh and the lines he had installed had a 69° bosh. With a furnace 100 feet high, with a 14 or 15-foot hearth, he was getting 125 or 150 tons a day and he was having trouble all the time.

Now we come to the comparison of an 1880 furnace and the present day furnace. The furnaces lines shown heavy (Section 4-Fig. 3) were drawn by our friends in Chicago as an illustration of a good modern furnace, showing how it had the same bosh angle as the 1880 type but they cut off quite a lot of the bottom and put in a 16′-6″ hearth, 20-foot bosh, and still have about the same diameter in the stock line, about 15 feet. Having a lower bosh they had better results but when they went back to the flatter bosh angle they never had satisfactory operation. The dotted lines on the outside show the ideal furnace, as given out by the Chicago Iron and Coke Association peopie—29′ 3″ bosh, and a 19-foot top. This was their idea of an ideal furnace. It is a very consistent furnace, considering all of our developments, and should give excellent results. As I said before, it has approximately the same bosh angle as the older furnace but is wide at the bottom. They have widened the bottom of the furnace but have kept the top almost the same diameter. The old one is 17 feet, and I think the proposed one is 19 feet.

Fig. 4 shows another furnace which is extreme as to the development of the hearth. It is 28 feet 6

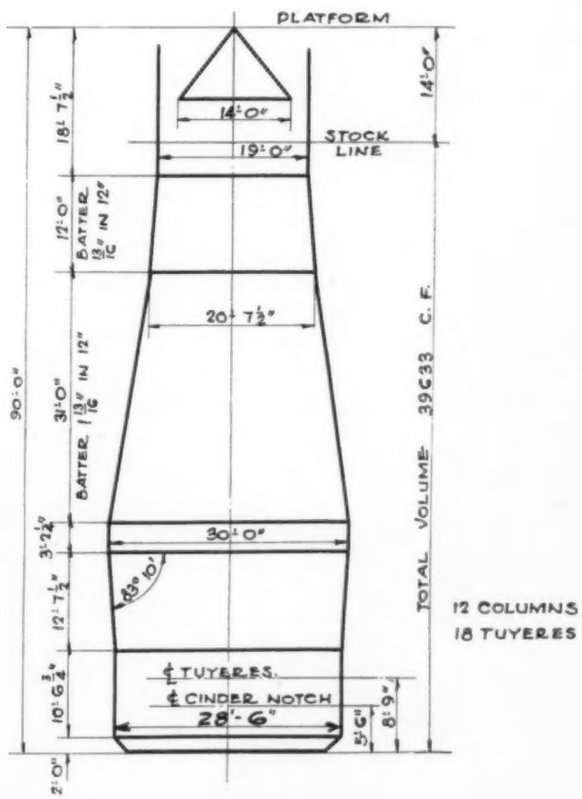


FIG. 4.

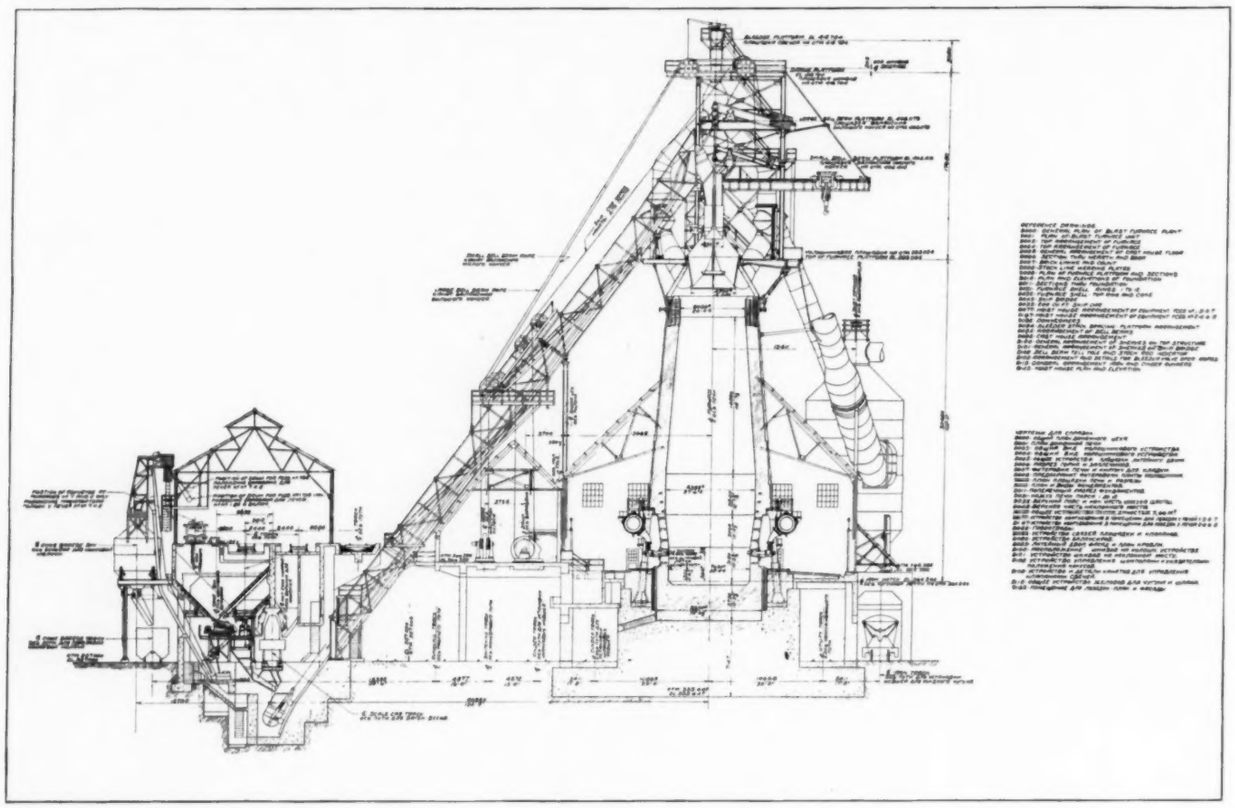


FIG. 5.

inches at the bottom, 30 feet in the bosh, and 19 feet 6 inches at the top. That is the extreme development of the hearth up to date, and it gives you an idea how the furnace has been widened at the bottom, while the top has been left practically as it was in the old days.

Fig. 5 shows a furnace that we built for the Russians. This furnace was designed a little before this ideal furnace was designed in Chicago. It has a 25-foot hearth, bosh 28 feet 6 inches, and a 20-foot stock line. I wanted to make the stock line bigger but I couldn't persuade our Russian friends to go farther than 20 feet. So far as we know this furnace has given satisfactory results. I show you that merely to indicate the possibilities in the development of the top diameter to greater dimensions than you usually find.

You know, it is hard to say just where we are going and anybody who starts to prophesy is subject to criticism, and very likely the development as suggested by any one person may be in a direction different than a later development which proves him wrong. I suppose I might be subject to some question as to whether I should propose the different things to you men who know so intimately the blast furnace development and trend.

You may be interested in the story of the old man who had a beautiful crop of whiskers, of which he was very proud. His granddaughter was sitting on his lap one day, and she said to him, "Grandpa, do you sleep with your whiskers inside the covers or outside the covers?" And he said to her, "I'll tell you, Martha, I never thought about it." She said to him, "When you go to bed tonight you just think about it and tell me in the morning." The next morning he came down stairs to breakfast and when the little granddaughter looked at him, she said, "Grandpa, what happened to your whiskers!" He said, "Last night when I went to bed I thought about what you said. I put my whiskers inside the covers and I wasn't comfortable that way, then I put them outside and I didn't feel comfortable with them outside, and I kept doing that all night long. Finally I got up and cut the darned things off."

I don't know whether it is wise for a man in my position to put his head under the covers or take it out from under the covers and say what he thinks. But I am inclined to do the latter and tell you what I think about some of those things.

Fig. 6, Section 8 shows a furnace which was experimented with by Kinney, Joseph & Royster, in which they determined with very considerable accuracy the combustion zones as they existed in a blast furnace. A horizontal cross-section shows the areas of these combustion zones. The squares are 3 foot six centers, and the combustion zones were reasonably close together. The central part is what the Germans call the "stille mann," meaning the "dead man" in the center of the furnace. The section outlined in the center, as far as we know, is occupied by coke. It is inactive and doesn't move excepting as the bottom of the mass of coke is dissolved out by the iron in taking up carbon before it is tapped. The experiments proved that the iron went down

through the outside zone, the carbon was burned out to about one per cent, and then as it got down in the hearth, came in contact with the coke which was resting on the bottom of the hearth, and the iron reabsorbed the carbon until it had the standard analysis of about four per cent. This "dead man" in there, as far as I can tell, is a waste of space. It doesn't do anything. The coke is there and fills the space. That is about all you can say for it was the exception that the coke laying on the bottom of the hearth does give to the iron the necessary carbon before being tapped.

Section 10, Fig. 6 is another furnace which is 25 feet in diameter and has the same combustion zones. One side shows a 16 tuyere arrangement and the other a 22 tuyere layout, indicating the difference in design and the form of furnace you would have if you put tuyeres in as closely together as they are in the latter case. That gives you a very much larger combustion area through which the iron and slag is passed down to the bottom of the hearth and should give you a better reaction and better iron quality. Of course, my friend Bill Haven says the less tuyeres you have and the bigger the hearth the better the operation. But in this case I am suggesting the possibility that that isn't the best statement of the situation. Kinney, in his paper, suggested the making of an oblong furnace hearth which would have no core, and he suggested having the entire bottom area of the furnace occupied by a series of closely placed combustion zones so that all of the iron and slag will go down through this high temperature zone. I am not advocating building a furnace like that, although it is, of course, just exactly what they do in the copper smelting furnaces and they work satisfactorily. It is an extremely radical suggestion, but it does have one advantage (if Mr. Kinney and some other people are right) in having the metal and slag doing down through the high temperature combustion zones. In fact the construction shown Fig. 6, Section 10, with 22 tuyeres is like that, but when you think about the "dead man" which is a dead space over which the coke and other stock slides down to the combustion zone, you really have that space surrounding the "dead man" and through which space the material must pass, to a large extent, occupied by combustion zones of high temperature.

That is a radical suggestion and contrary to the beliefs of many people. But the people who made such an intimate study of this furnace and other furnaces have made the suggestion that we should have a larger combustion area in the bottom of the furnace, and it is just possible that a furnace of that design will give us better results that a furnace having less tuyeres and less space.

The furnace shown on Section 6, Fig. 6, has given excellent results. It is 18 feet 6 inches in the hearth, 22 feet and 3 inches in the bosh, and 18 feet 4 inches in the top. There is a furnace which has practically the same diameter top and bottom, with a large area for gases to pass through the stock in the top of the furnace, with a minimum of entrainment of flue dust in the outgoing gas.

Along these same lines, but not as extreme as that, I have drawn here a section of a blast furnace that has a 25-foot hearth, 28-foot bosh, and a 22-foot top (Section 7, Fig. 6). It should give good results, unless the 22-foot top does present unseen difficulties.

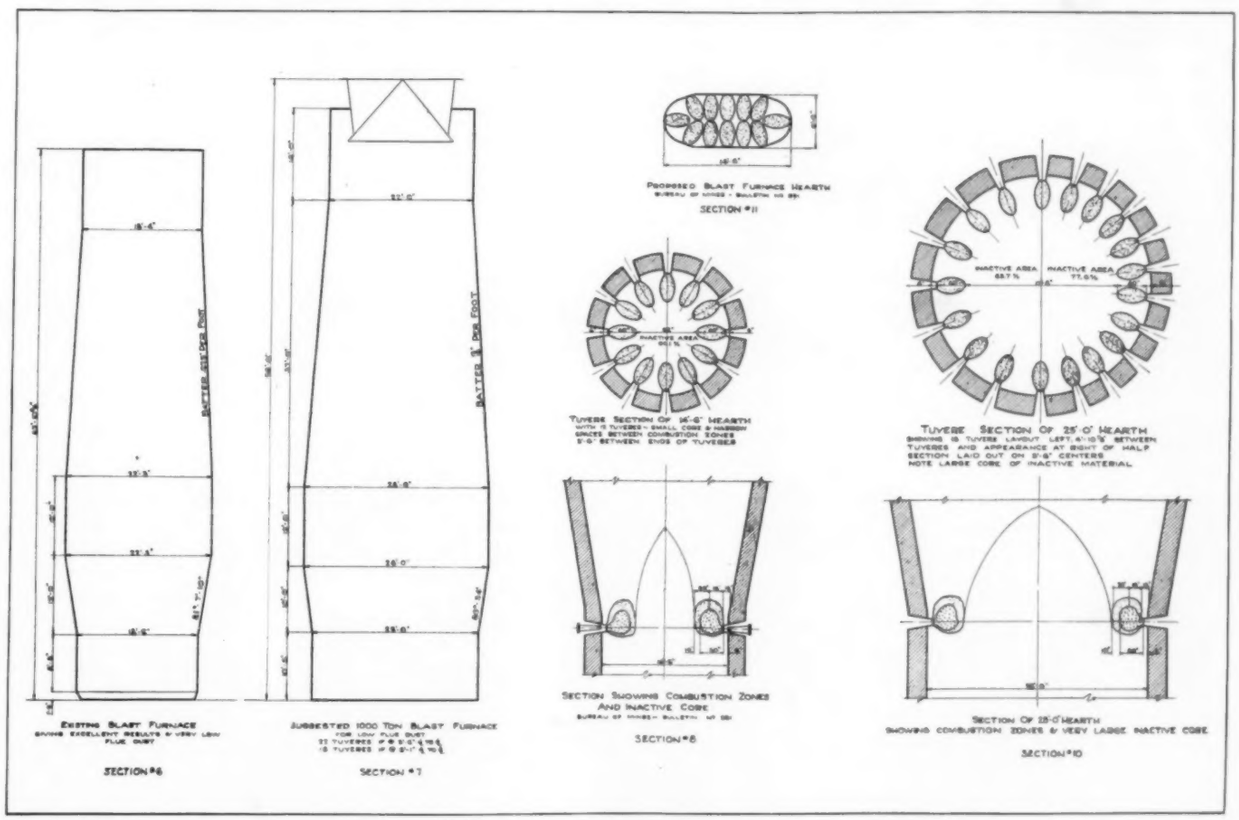


FIG. 6.

Of course in the old days we had a 17-foot top, which was standard for a great many years. During the last few years they have crept up from that to an 18-foot top, and I think one of the last furnaces was 19 feet 6 inches. I don't see any reason why a 22-foot top, or even larger, cannot be used on present equipment. At any rate, I can say this, without any chance for contradiction for the moment, up to date we haven't any experience in the operation of a blast furnace with more than 19 feet 6 inches, or 20 feet at the top. They worked all right as far as distribution, both radially and angular, is concerned. I can see no reason now why a 22-foot top, or greater, wouldn't give as good or better results. Undoubtedly you will reduce your flue dust losses as you make the diameter of the top greater.

Section 12, Fig. 7, shows another furnace which goes a little farther in the direction I have suggested and, of course, I don't know whether it will work well or not. As I say, we haven't had any practice to indicate it won't work as well or better than other furnaces. It has a 20-foot hearth, 24-foot bosh, and a 22-foot top. That will give you a smaller batter in your in wall. I think it is 5/16 inch. It is an extreme departure from your present situation. I don't see any reason why this furnace should not operate as well as the 18'6" hearth that I showed you a little while ago.

The iron you use is definitely related to the amount of air blown into the furnace. This furnace would have 20 tuyeres. That would give you almost a continuous high temperature combustion zone around the furnace and in the middle you have your "dead man" which serves as the other side of that oblong furnace, as suggested by Kinney. It keeps the stock moving down into this high temperature zone. This drawing was made after the other one, and I have shown the approximate way the coke rests on the bottom of the furnace. People tell you it doesn't rest on the bottom of the furnace. It is only reasonable to believe that coke will go down and actually rest on the hearth of the furnace, and that coke must stay there until it is dissolved out by the iron surrounding the bottom of the "dead man," giving you the right amount of carbon in the iron. In other words, that "dead man" can't move or change because it is undoubtedly kept free from any oxygen, since we are assured by Kinney and his associates, by German investigators and others, that the carbon dioxide never gets further than six inches from the tuyere. Surely if you blow enough air you come to the question of the resistance of the gas movement through the small area, and it is possible that it will not be entirely satisfactory to go to this extreme. But this furnace will undoubtedly give you the air needed for the production of a very large amount of iron, and also give you ample volume where the iron is reduced by coming into contact with the carbon monoxide. Carbon monoxide, as the reducing agent, will reduce iron ore as it passes through the temperatures that you get, down to 600° F., the space in which direct reduction takes place is the volume noted as "zone of incandescent coke." In other words there the carbon dioxide (or monoxide) will dissolve coke and cut down the efficiency.

Above this zone you arrive at a temperature where the condition of your coke will not reduce your carbon dioxide, and from there up all of your carbon

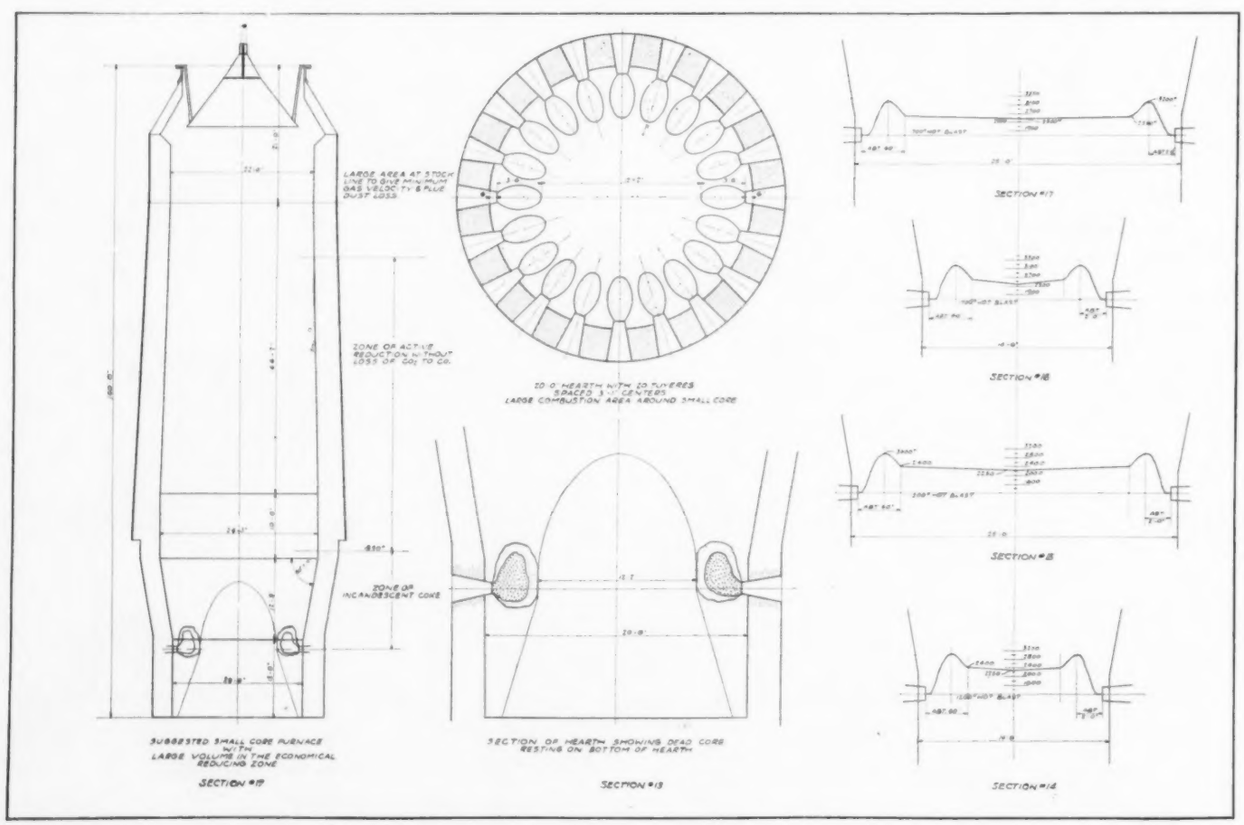

SUGGESTED SMALL CORE FURNACE WITH LARGE VOLUME IN THE ECONOMICAL REDUCING ZONE
SECTION #17
SECTION OF HEARTH SHOWING DEAD CORE RESTING ON BOTTOM OF HEARTH
SECTION #13
SECTION #17
SECTION #16
SECTION #15
SECTION #14

FIG. 7.

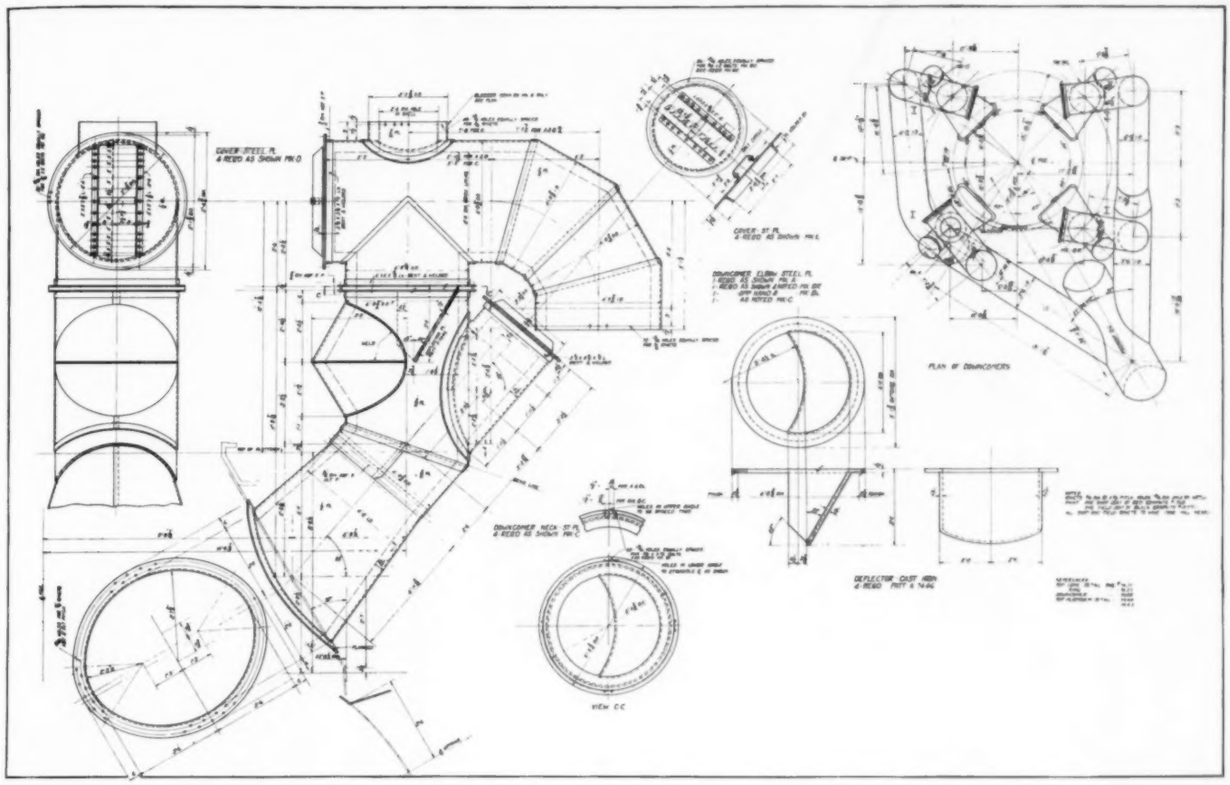


FIG. 8

monoxide changes to carbon dioxide in reducing the iron ore, and will stay carbon dioxide, with the result you have increased efficiency in the operation of the unit. What we need then is a large volume in the furnace above this point of loss of carbon dioxide and that is obtained by making this a very large diameter. And you also get an objective in having a large diameter in that you have a low velocity in your gases and a minimum of entrainment of the fine material carried out in the gases.

Here is another thing you may or may not have thought about. When you blow air into a blast furnace it first combines with the incandescent coke and forms a considerable percentage of carbon dioxide. This is almost immediately reduced to carbon monoxide. Of course, when you burn air and carbon to carbon dioxide, you release some fourteen thousand B.T.U's. per pound of fuel, and when you bring it back to carbon monoxide you have virtually a refrigerating effect, and heat will be reabsorbed in the cooling effect in the reduction of that carbon dioxide and carbon monoxide, or the loss per pound of fuel in heat is something like ten thousand B.T.U. When you blow air into the blast furnace your temperature immediately jumps up to about 3000 degrees. This is taking the Kinney furnace, having a blast temperature of about 1200 degrees. That immediately jumps up to 3000 degrees, and then almost as suddenly it drops down again to 2300 or 2400 degrees and then tapers off to the center of the furnace, or the "dead man," to a temperature of 2000 or 2200 degrees.

That is a peculiar situation, which develops the fact that your blast furnace has an intensely high temperature in each of these combustion zones which immediately drops off, not by radiation of heat (although that has some effect), but more largely due to the refrigerating action of the carbon dioxide changing to carbon monoxide. And the center of the furnace is accordingly a good deal cooler than the combustion zones. I suppose all of you have heard talk about the cold center of a furnace. I have told people I would like to catch up with one of those cold centers. It is easy to imagine it might have a much colder center than we have knowledge of, and the old experiment of sticking a bar in the furnace and having the bar extremely hot at the tuyere and not even red on the inner end might well be demonstrated and might well be understood in view of this situation.

Fig. 7, Sec. 15 shows a large furnace with a 25-foot hearth, with the same condition, showing that low temperature area for the entire core, or "dead man" in the furnace. It also illustrates the desirability of high blast temperatures in that if you blow the furnace with 1700°, instead of 1200°, Fig. 7, Sec. 17, the temperature will go up to 3200 or 3300 degrees and then drop down to about 2400 degrees in the center, giving you better operation and also better quality of iron.

Now as to auxiliary equipment. As a matter of fact I will have little time to talk to you about auxiliary equipment today because this talk is limited in time. And I don't want to bore you.

Fig. 8 shows a very effective baffled offtake. It can be made in a number of different forms. This

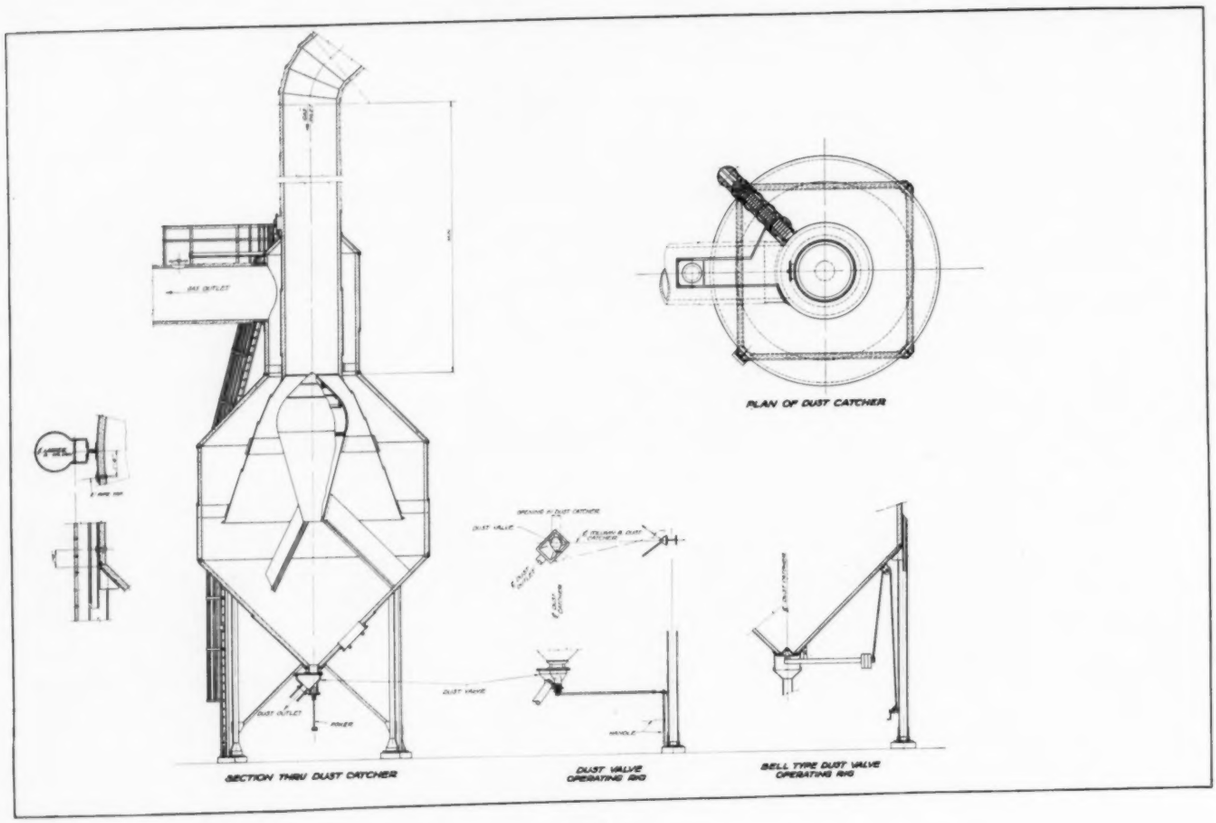

PLAN OF DUST CATCHER
SECTION THRU DUST CATCHER
DUST VALVE OPERATING RIG
BELL TYPE DUST VALVE OPERATING RIG

FIG. 9.

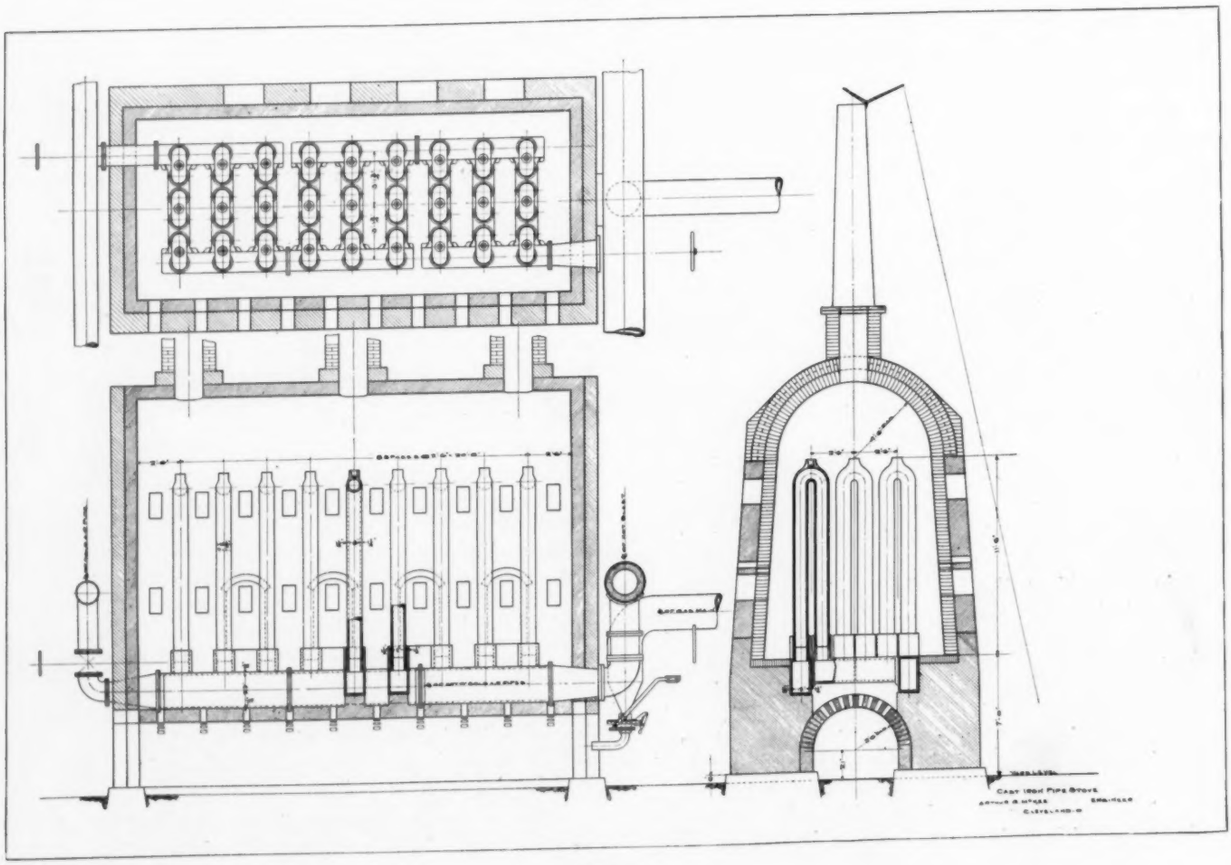


FIG. 10.

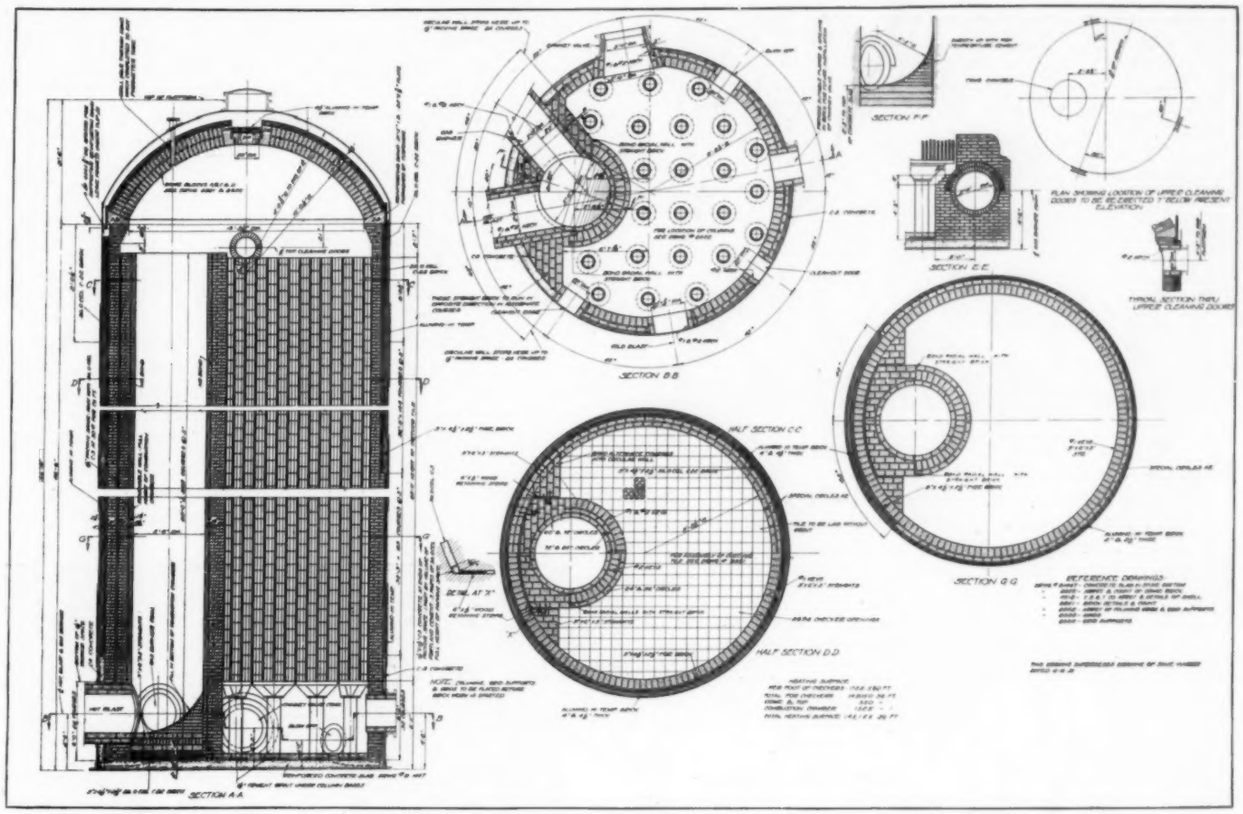


FIG. 11.

has been entirely effective in preventing large materials passing the baffle.

Fig. 9 shows a type of dustcatcher which we have been developing and is one in which we are very much interested.

One night I had the pleasure of listening to a speech made by a navy officer on the design and construction of the Zeppelin "Akron," built by Goodyear, and he told us how the ship in passing through the air, having a blunt point and a sharp rear, would cause a minimum of disturbance of the air surrounding the ship, and after it passed the air in back of it was without commotion. That gave me an idea, and I sketched a dustcatcher with the idea of getting the gas in the dustcatcher with a minimum of velocity so there would be practically no eddies in it. After we built one of these dustcatchers we discovered that it does eliminate the eddies to a remarkable extent, and the gases, when they get to the level of the bottom of the core, are going at a very slow velocity and almost no commotion. Then the gases pass out around a skirt and to the further cleaning equipment, with a very large reduction in the amount of flue dust. As to further cleaning of gas I believe by all odds the best equipment today for final cleaning is the electrical precipitator. It has proven very satisfactory.

Fig. 10 is a drawing I took out of our old files. This is a pipe stove. You know, in the old days blast furnacing was far from easy. I can well remember the old blowing engines with sole-leather valves, and they were terrible. The old boilers had two flues in each drum and there was always the constant dread and fear on the part of the operator of the loss of steam pressure. He never knew just where he was standing. Running a blast furnace was a terrible job with many hazards and there were many physical dangers. The accidents per employe were very, very high.

This device was one of the first means of getting pre-heated blast. The horizontal boxes are made of cast iron, and pipes of cast iron, so the air came in through the boxes, went up through the pipes, traveling across the stove. The gas was burned in the tunnel beneath and the hot gases went up through the holes around the pipes and heated the gas so it was possible to get 700 or 800 degrees F. Of course, it required a lot of care and attention, because if you got the gas burning a little too vigorously you softened these pipes to the point where they would gracefully and affectionately lean over on each other. As a result the stove would have to be taken off and new pipes put in.

Fig. 11 shows a stove with small checkers, insulation and metal supports on the bottom. It is really a very efficient modern unit for heating. The checkers are staggered so they can't slip and get across on top of each other. The supports are positive and support the entire bottom area. The bottom bricks are supported so there is no possibility of them letting down. The whole stove is a thoroughly solid, substantial structure.

Fig. 12 shows the top of one of these stoves and the large area available in the checkers.

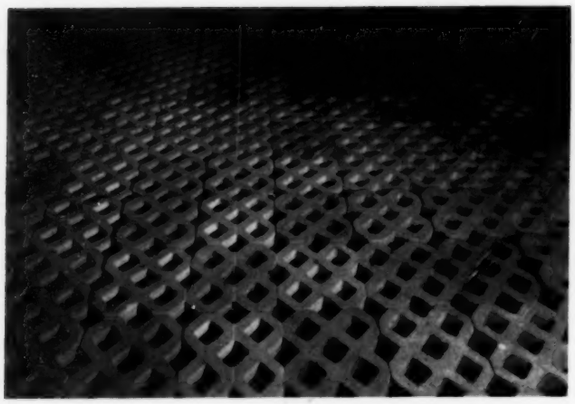


FIG. 12.

Fig. 13 shows the bottom of the stove with the iron columns, and you can see how the bricks are supported, making it impossible for the bricks to let down and cause the trouble that so many of us have experienced with brick arches, which were the customary construction until recently.

Up to the present time there has been a peculiar lack of really conclusive information as to the operation and characteristics of hot blast stoves. Many of our people, both here and over in Europe, have made extensive tests of the temperatures of the brick work, blasts at different levels in stoves. This information has never been correlated or brought together in a way to make it available for predetermination of what a stove will do or what it should do. So, after talking to our fellows for a long time, about two months ago, I put it up to our Mr. Thorne. I wanted him to work up something in the way of concrete worthwhile information about a hot blast stove. He took all of the available information from various sources, and started to calculate what a stove should be like and what it should do. He found that the curve of temperatures was a parabola. My calculus and other higher mathematics were sketchy, so I put it up to Thorne. He found if you had a gas temperature going into the top of the checkers of 2300 degrees, you would have, with a comparatively cold stove, a parabola, with a bottom temperature of 243 degrees. He also figured the temperature of the blast, on the same basis, which started at the bottom at 150 degrees, depending on the pressures and outside air temperatures, and you would have a corresponding curve up to 1500 degrees. From that he calculated the temperature of the brick, which would be 200 degrees at the bottom and 1900 or 2000 degrees at the top. That gave him an idea of the temperatures at the time the stove was heated up to a certain temperature, and also the air going through, with the brick and other conditions the same.

In order to make this a picture of the actual stove, he took these three curves I have just described to you and put them on the side of a cube, Fig. 14. Then, starting with the brick at a temperature of 1934, you follow the curve, which is also a parabola, until you get up to a temperature of pretty near 2300 degrees at a time when you take the gas off the stove and put the air on. Then he also figured the curve of the brick temperatures at the end of the heating period and he found he had about 480 degrees temperature at the bottom of the brick. This is figured on the basis of 4½-inch square checker, and a 2-inch wall. During the period of operation on the blast you follow down on this curve and arrive at the point where we started, giving us a complete cycle of brick temperatures, and all of them, as Mr. Stubblefield has aptly said, in a box. You have there the temperature of the brick work from the bottom to the top at the beginning of the heating period and you have the curve of the change in temperatures at the top and at the bottom during the heating period up until the brick is heated to its maximum. And then you have the curve of the brick temperatures following down through the stove, and also the curve indicating the drop in temperature of the brick in the bottom of the stove while the stove is on the furnace.

Fig. 15 is another chart in which I have carried all of these curves clear around the stove and put all of the characteristics into the same box. You have the temperature of the brick as a center curve, and

FIG. 13

by taking any cross-section through this, you could determine just what the temperature of the brick is at any level of the stove at any period during the heating cycle.

The gas temperature curve—(and, by the way, it is somewhat modified due to the fact this curve is a projection of the curve on the other plane which is made necessary by the fact that it takes a certain period for the gas to heat up the combustion chamber and the dome of the stove before you get the same gas temperature going into your checkers), represents approximately the temperature of the gas which starts at the top, say 2300 degrees, and comes out at the bottom at 242 degrees. As the stove heats up, the curve follows along and you have the same gas temperature but your gas at the bottom (still the 4½x4½x2-inch checker) has a temperature of 620 degrees. Then at the same time the stack temperature would start at 242 degrees and run up to 620 degrees at the end of the heating period. Your brick temperature will follow around just below that and you will have a maximum brick temperature at the bottom of 480 degrees and at the top pretty nearly 2300 degrees. Of course, the air will start at 150 degrees and heat to approximately 2300 degrees and gradually drop off in temperature until you get

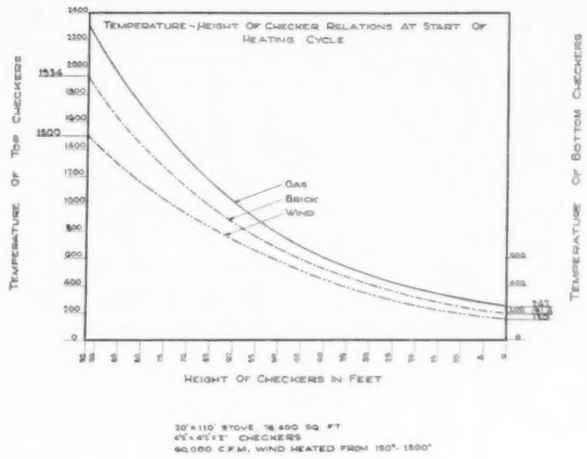

TEMPERATURE - HEIGHT OF CHECKER RELATIONS AT START OF HEATING CYCLE
TEMPERATURE OF TOP CHECKERS
TEMPERATURE OF BOTTOM CHECKERS
GAS
BRICK
WIND
HEIGHT OF CHECKERS IN FEET
20'X110' STOVE, 78,400 SQ. FT.
4½"x4½"x3" CHECKERS
60,000 C.F.M. WIND HEATED FROM 180°-1500°

FIG. 14.

down to the final temperature which, in this case, is 1500 degrees. And the temperature of the air in the different levels of the stove, is shown by this curve.

Fig. 16 is another stove in the box, same sized stove, 167,000 square feet of heating surface, 1-inch walls. The gas starts in at 2300°, and its curve follows around just like in the other chart. But you will notice that the stack temperature is 371 degrees and the gas will be 1500 degrees temperature at the end of the one hour period on the furnace. That

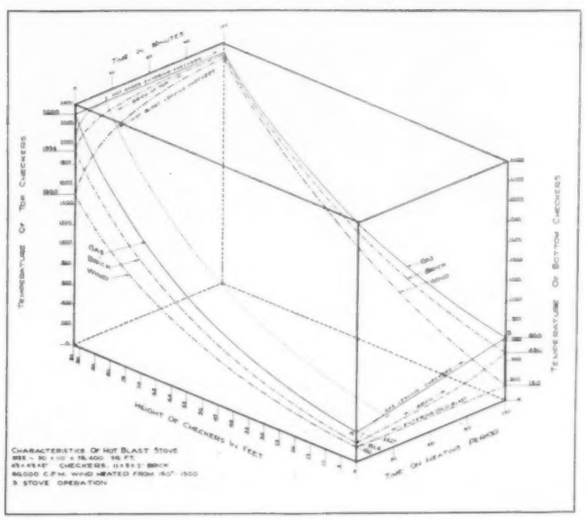


FIG. 15.

gives you a much more efficient operation, particularly because you have so much lower stack temperature.

Fig. 17 is the same stove, 1¾-inch checker, and a 1-inch wall, set up for 60,000 cubic feet of air, and to maintain 1700 degrees temperature. We begin at 494°. Here you have a combustion temperature of gas going into the top of the checkers at 2300 degrees, which is a maximum for the best combustion of good blast furnace gas. This is a basis, I believe, on which we can determine in advance what stove we require for a certain set of conditions. The plan hasn't been worked out to a point where we have as much data on its accuracy as I would like but we are making progress in that direction, and I will appreciate your co-operation in giving us any additional information in regard to stove performance that you may have so that we can further check this plan of predetermining the qualities and possibilities of a stove for a certain set of requirements.

As I said before, the gas temperature curve on the other illustrations, also the stack temperatures, have necessarily been modified somewhat from the actual

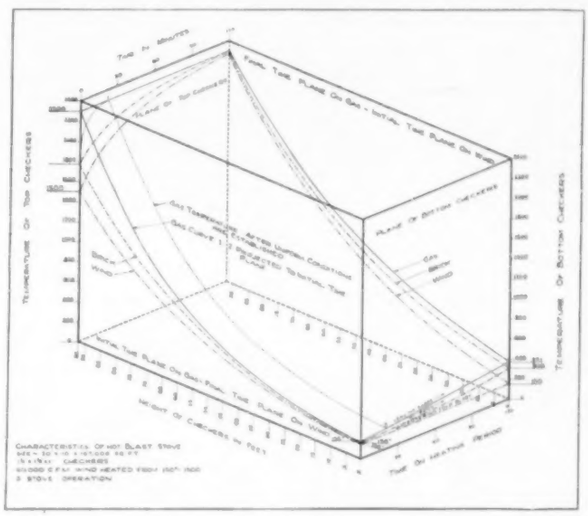


FIG. 16.

curve because of the effect of the low temperature of the gases coming into the top of the checkers when we start to heat the stove. We have stack temperatures that normally look like the dotted line (Fig. 18) on account of the low temperature of the gas going into the top of the checkers in the first few minutes, and also on account of the loss due to changing the stoves, whereas we have modified it (full line) so as to make it fit into our chart to the extent of taking an average of those temperatures.

In our discussion of the stove and of the furnace I have tried to stress the importance of getting high

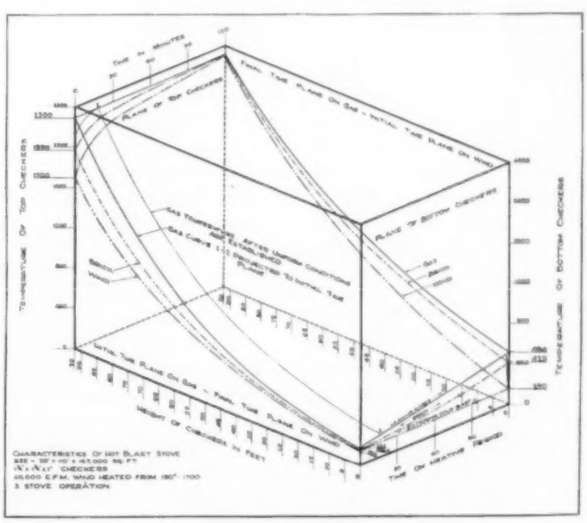
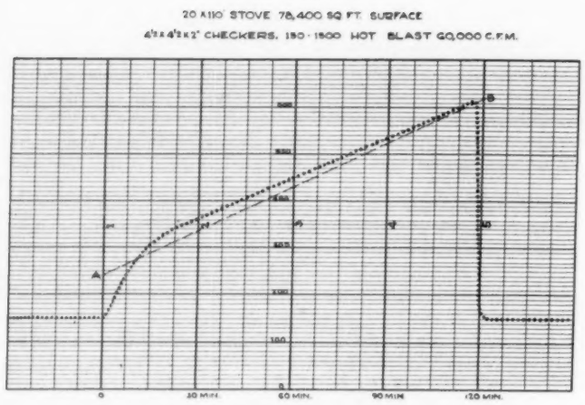


FIG. 17.



STACK TEMPERATURE CURVE
PLOTTED ON TYPICAL COORDINATES
A - B SHOWS CALCULATED STACK TEMPERATURES
DOTTED CURVE CORRECTIONS FOR INITIAL HEATING OF COMBUSTION CHAMBER AND TIME LOST DURING STOVE CHANGING

FIG. 18.

gas temperature. I now want to speak about something else. If you are using high gas temperature, your loss of temperature from your combustion chambers to your tuyere is a very considerable item, and that loss is taken off the top of your temperature where, by all odds, is most valuable. I have seen records of 250 degrees loss in temperature from the combustion chamber to the tuyere. That is a terrific penalty to pay after you have put your temperature up to where you want it. You don't get it in your furnace at that temperature.

Fig. 19 shows you the bustle pipe. The hot blast pipe will be made the same way, with one inch of insulating cement on the outside, one and one-half inches of ordinary firebrick laid in high temperature cement. And then an insulated blow-pipe which is made of a high temperature steel tube liner and then an ordinary steel pipe on the outside the space between being filled with insulation. There is a minimum of high temperature steel castings on the two ends so as to give ball and socket joints. We have used this insulated pipe to a very limited extent. It has been tested for six or eight months and found to be highly satisfactory for the reason that even with 1600 blast temperature the outside tube of that blow-pipe will have a temperature of not more than 450 degrees F. It not only makes for safety in operation but also assists in the saving of the heat losses which in former practice has been terrific.

There is another factor which has been overlooked by a number of people. I have seen blast furnaces with one stove on the furnace for one hour, and on gas for two hours. As I showed you on these charts, you have the stack temperature during the heating period going up and up. Now, how are you going to put a stove on a furnace one hour and gas two hours and get a stack temperature that is moderate? But if you leave that stove on two hours and gas four hours, you will have a very much higher stack temperature, with the result that you will have a very serious loss in efficiency and gas consumption. That is one thing that I think might well be modified, even if it does make the stove tender do his job twice as often.

With high blast temperature; as I pointed out in those curves, showing the temperature of the furnace from the tuyere towards the center, if we have a higher blast temperature we have a higher general distribution of heat over the entire area, and even the "dead man" in the middle of the furnace will be correspondingly hotter than it otherwise would be. So, by getting the higher temperature blast you increase your efficiency in operation. Of course, some of our friends say they have difficulty in maintaining good operation with very high blast temperatures, but the temperatures used have climbed up very materially from the time I first was familiar with blast furnace operation. In the early days 800 degrees was a hot blast furnace, whereas today they run as high as 1600 degrees. Most furnaces now are operated at an average temperature of around 1200 degrees. I am speaking of the average, but many furnaces are working around higher temperatures. I think we can work out still higher temperatures, particularly with the insulated blow-pipe. And at the tuyere you will have 1600 or 1700 degrees. I am satisfied when you get to that point you will have a better and more efficient operation than you have at the present time. As to the factor that the temperatures in the top of the furnace are lower because of higher temperatures at the bottom, some people may want to question that. But I think it is a fact. You get better results with lower temperatures at the top and higher temperatures at the bottom.

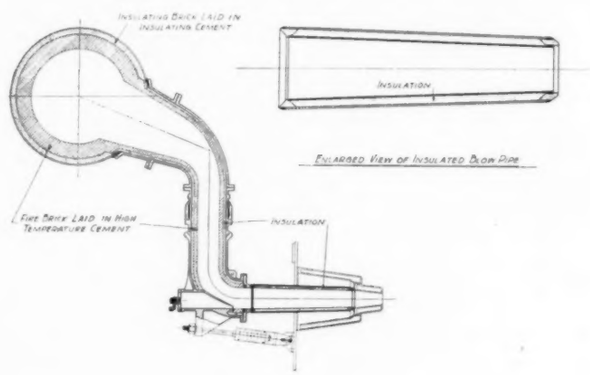

INSULATING BRICK LAID IN INSULATING CEMENT
INSULATION
ENLARGED VIEW OF INSULATED BLOW-PIPE
FIRE BRICK LAID IN HIGH TEMPERATURE CEMENT
INSULATION

FIG. 19.

When we were working with the Russians building a furnace for them there was a very interesting little fellow who had the curious habit of keeping his head shaved. He was very well set up and mentally brilliant. After he had been here for some months he came in one day with the usual program of complaining because we weren't making fast enough progress to suit him and his people in making the drawings and specifications. He started out as he did many times before with the complaint that they were behind with different schedules. When he came into the room on this particular day he said, "Mr. McKee, I talk myself today." He had learned enough English so that he thought he could talk without the aid of an interpreter. As I say, he started in to complain because we were behind in making up the drawings and specifications. My partner, Mr. Baker, said to this little fellow, "We

are behind with these different schedules but the Russian Government owes us $102,000.00 and is still behind two weeks. We are behind and you also are behind." He thought for a moment and then he said, "Ah, yes, I don't want to talk about my behind; I want to talk about your behind."

I want to tell you that these things I am talking to you about are not my behind; they are your behind. I don't have a blast furnace to play with, therefore I can't do things with a blast furnace as you can. I want to suggest that you follow these things along and see whether I am right in my suggestions. If I am wrong, find out what is right. Let us make this "behind" into a "before"; let us get to a point where we really have improved the blast furnace to a point where it is as near to perfection as we can get.

I want to say a word for the Bureau of Mines and the work they have been doing. There is no doubt they have done fine work in giving us a lot of information we didn't have before. Our government is spending lots of money for some things that all of us perhaps don't approve of, but it has cut down on the experimentation in blast furnace work. This research work is important, and I think it might be possible, if there were concerted action on the part of the people in the iron and steel business, to get the government to at least restore the program so that the Bureau of Mines might go ahead and furnish us with more and more valuable information, which I know they can do. Of course, there is another direction in which this might be done with excellent advantage.

The open hearth furnace has never been investigated in a serious way by anybody. It hasn't been checked so that people know about the open hearth furnace, even as much as you know about the blast furnace. And we need lots more information on blast furnace work.

The other day I was talking with a purchasing agent who is a very competent and reasonable sort of fellow. I said something about firebrick for open hearth furnaces, that they might well have a much higher grade of firebrick if they would pay the price for them. He said to me, "They talk about firebrick at one dollar a brick!" I said to him, "All right, but if you could build an open hearth furnace with brick at one dollar a brick and make the open hearth furnace run for six or eight years, the same as a blast furnace will, and incidentally use your flame temperatures at the maximum you can get, rather than the maximum you can possibly use without melting down the roof and sidewalls, you might better use the dollar-bricks. If you would give the firebrick companies enough money for their bricks, so they could have some money with which to do some research work and possibly have a little money with which to pay dividends, they might and probably would develop for you a firebrick for the open hearth furnace that would withstand the high temperatures."

I don't see why our government couldn't get back of a program like that and try and determine what an open hearth furnace is like, along the lines we have been working in connection with the blast furnace.

I said in the first place I was going to try to be something of a signboard this morning, and if I am pointing in the wrong direction I may get my block knocked off. I was asked to tell something about fifty years of blast furnace design and something about the future design of blast furnaces. I have stuck my ears up and made some suggestions.

Aunt Het, a few years ago when there was such wild discussion about evolution, said she didn't want to believe in evolution but every time she looked at her husband's cousin Oscar it made her think. If what I have said this morning will make you think constructively, my time and yours will have been well spent.

Discussion

Discussion presented by

G. R. McDermott, Vice President, Surface Combustion Corporation, Toledo, Ohio.

A. G. McKee, President, Arthur G. McKee & Company, Cleveland, Ohio.

J. C. Hopkins, District Sales Manager, General Refractories Company, Cleveland, Ohio.

B. M. Stubblefield, Supt. of Blast Furnaces and Coke Ovens, Youngstown Sheet & Tube Company, Youngstown, Ohio.

L. E. Riddle, General Superintendent, Carnegie Steel Company, Isabella Furnaces, Etna, Pa.

G. R. McDermott: Considering the auxiliary equipment installed in connection with blast furnaces, I would like to ask Mr. McKee if an instrument giving a record of the CO-CO_2 ratio or CO content of the gas leaving the furnace would be of assistance in the proper operation of the furnace. I have in mind such an instrument which would give an indication and also a continuous record of this determination. The determination would be accomplished in a comparatively short time, a matter of seconds. The instrument would depend on an electrical determination calibrated in percent of the CO content of the gas and not by chemical absorption. Furthermore, would such a record call for a variation of the blast temperature to meet the situation?

A. G. McKee: I don't know whether a knowledge of your CO-CO_2 ratio would be a satisfactory workable ratio for varying your hot blast temperature and give you better operation. I am going to ask some of my friends who are actual operators of blast furnaces to tell us what their opinion would be.

B. M. Stubblefield: It so happens that we have had some experience at the Campbell Works of the Youngstown Sheet & Tube Company with an instrument which took a sample of the furnace gas and determined the CO and CO_2 content of this sample automatically. This experience leads us to believe that a continuous record of the CO and CO_2 content of the furnace gases would be very valuable to the operators.

Due to the fact that we tried to operate this machine on gas which had received only primary wet washing—it was a source of continuous trouble. Furthermore it was inaccurate.

It is my belief that a person who develops an apparatus that will take continuous samples of the top gas and perform an analysis upon them—with a fair degree of accuracy—will have made a real contribution to the industry.

Have any others had any experience along this line?

J. C. Hopkins: We experimented considerably along that line in the early days by making frequent gas analysis, but the interval of time between taking the sample and getting the analysis was so great that the information was only of a general nature. Under these conditions it was impossible for the operator to correlate CO CO_2 ratios with blast temperatures, burden ratios and furnace conditions and take immediate corrective measures.

Blast furnace conditions change so rapidly that it is imperative to know immediately of any change. Later we tried various continuous recording instruments but as a rule these were not dependable.

Without a doubt, the CO CO_2 ratio is fundamental in blast furnace operation. If the operator had a continuous recording instrument showing this ratio, it seems to me, it would be very helpful. Blast temperature, wind volume and burden ratios could then be better correlated, which could make for better furnace operation.

After all, one of the important factors which has made modern blast furnace practice possible is the various instuments to record continuously and accurately, temperatures, pressures, wind volumes, etc., and the prompt and proper interpretation of these data. The instrument which Mr. McDermott proposes is a further and valuable step in this direction.

L. E. Riddle: On the CO-CO_2 ratios, I never could see what a continuous record would do for you. I would not know what to do with it. I would like to have the ratio of CO to CO_2 occasionally to tell me whether the ratio of ore to coke is correct, but as to the CO-CO_2 ratio allowing me to make changes quickly, I see no advantage in it.

I took some notes as Mr. McKee made his talk, and I took notes for two reasons: I did not want a lot of good things that my friend, Mr. McKee, said to go over my head. I put them down in the dark.

Mr. McKee started out by saying that he wanted us to think. I am one of his old-time friends, and I am also one of the old furnace-men. I am so old that I worked on a furnace like that one he showed on the screen, hand-filled, single bell. I am old enough too that I can still think and comment about the old belief concerning the "dead man" or inactive part of a blast furnace. I am old enough to think that some of those things do not work that way. I used to get "heck" for making buckshot in the early days, and it was up to the fellow out on the furnace to prevent buckshot. I think old furnacemen knew what they were talking about when they stated that buckshot came from the cold center, that they could get a more active center, improve the iron and eliminate buckshot, by changing penetration.

In regard to increasing the number of tuyeres from the common practice of ten and twelve, some of us have worked on furnaces of a given diameter where we had ten tuyeres; with the same diameter we have used twelve tuyeres, and again as many as sixteen tuyeres. We have gone from sixteen back to ten. We got better results with the smaller number and do not believe that the space in between the tuyeres is entirely inactive. We know there is coke in the center and coke in the hearth. If it were not there we would not get the results we do—coke at the tapping hole and see nothing but coke before the tuyeres when a furnace is working properly. I think there is less entirely inactive portion in the furnace, which brings about the question of a large number of tuyeres as shown in some of Mr. McKee's designs, because when you take a furnace out you can see in between the tuyeres that there has been a great deal of action and erosion.

I believe it is not necessary to get the tuyeres quite as close together as Mr. McKee shows in some of his proposed designs, but we do have to get enough wind to take care of a given area. He has showed us many good things, and he is to be complimented on the things he brought out. It is difficult to cover a big subject such as blast furnace development in an hour or two. Everybody knows that we would like to bring about economy and efficiency in production. Arthur McKee is one of the foremost men in assisting to accomplish this, and if we cannot get the money for the purpose of continuing research work and new construction, we will keep going ahead the best we can and think about these things. He has told us a number of things this morning that will be very helpful . He told us about the necessity for proper combustion in stoves, and there is a lot of food for thought there. He said that years ago when he was about the furnaces, he could not use high heat, and I think he had real reasons for saying that. He had flat boshes, he had fine ores, at times poor coke, and when he tried to use high heat the furnaces would hang. I think most of us would like to have higher blast temperature. When engineers design our checker area to get the maximum benefit of our burnt gases, and show us how to get maximum heat, it will be a great help. I was interested in what he said about modern gas cleaning—progress in electrical precipitation, but I have been more interested in how to keep this dust out of the gas leaving the furnace.

I am glad that Arthur said a number of times today that he believed thoroughly in the top of the furnace being enlarged, as large possibly as the hearth area. I have been thinking about it for a good many years and have experimented along that line.

I am going to speak of Arthur's "behind", as the Russian did, because Arthur is behind a little when he mentioned that he would not go above a 19′6″ stock line on the 25′ and 28′ hearth furnaces proposed and shown today. I think on a modern large furnace it should be anywhere from 20 feet up to 28 feet. From my studies I can see no reason why a furnace should not have a minimum stock line of 25 feet, if the hearth is 25 feet, and a 28-foot hearth could easily be filled without having the trouble that many are afraid of—that bugaboo of distribution if you had a 25-foot stock line. In my opinion, this cannot be done with a single large bell. We spent over $10,000 at Duquesne in 1929 and 1930 in experiments on the top of a furnace out of blast. We experimented with two small bells and a distributor, eliminating a large bell entirely. I believe we can go to a 25-foot stock line with this Anderson-Miller type of distributor and bells, have a distribution which will be perfect, and obtain a V, inverted W or W filling as desired. When I speak of large tops of 19-foot or over, I mean where the ratio of top area has been kept equal or nearly equal to the hearth area.

In 1928 we built a furnace at Duquesne with 20′6″ hearth and 19′ stock line, 14′ bell; another with 19′

hearth, 19′ stock line and 13′ bell. Since 1929 have operated another furnace with 19′ hearth, 20′8″ stock line and have used both 13′ and 14′6″ bells on this.

Recently I heard a furnace-man speak about his furnace with a 19′ top not making a low flue dust record, that he could not get the results some others had with 19′ tops. Of course he did not because with his 25′ hearth, his 19′ stock line was not large enough, having an area ratio of only .58 to 1 hearth. Another man has condemned big tops because of his inability to get proper distribution. He has never had larger than an 18′ top with a much larger hearth diameter, and again his large bell was in my opinion too small. I believe one of the things we must realize is not to think of a 19′ or 20′ stock line as being a "big top", if the hearth diameter is much larger. I would keep if possible stock line to hearth diameter in ratio of at least 1 to 1 if possible. Large diameter stock lines are not a cure-all for eliminating dust entirely, because after all there are so many other things that depend upon Superintendence.

Stock line diameter is not a cure-all for dust reduction, but with one of ample size in relation to its hearth diameter when compared to one of small improper sized top with a large hearth, it gives an advantage much like the runner who has light spiked shoes over a competitor with heavy smooth soled shoes.

I was interested in that part of Mr. McKee's talk having to do with the insulation of blow pipes. A lot of us have taken care of the insulation of hot mains and bustle pipes but we did not eliminate the heavy loss between these and the tuyeres. Mr. McKee with his insulated blow-pipe has surely made a step in the right direction, and his insulated blow-pipe looks practical.

All of this talk has been very interesting, and I know the importance of it will grow as we study over it. I hope we can carry out these improvements necessary to economy and efficiency. I agree with him that when we make changes and install new equipment, that we not only prove its worth and correctness, but make further study and improve upon the design. There is much to know.

B. M. Stubblefield: There is one point in Mr. McKee's discussion that I would like to hear an expression of thought on. You will remember he told you he thought we should reduce the hearth diameter from 28 feet to 20′6″—yet continue to produce 1000 tons of iron per day.

I would like to have the blast furnace operators say what they think about casting such a furnace. Is it possible to hold the quantities of iron that such a production rate would require in a 20-foot hearth furnace without serious trouble with "breakouts"?

A. G. McKee: Don't forget that Frazer first made one thousand tons on a 20-foot hearth.

L. E. Riddle: We have not yet learned how to keep a tapping hole open and iron running from it continuously. A design was shown suggesting that we might double the number of tuyeres and make as much iron on a 20-foot hearth as can be made on a 23, 25, or 28-foot hearth. I do not believe this. It is my opinion that if we blow enough air per sq. ft. of hearth area, we will get the tonnage for it, and will get a proportionate increase in tonnage when the larger furnace is properly blown for size. We should get 2 to 2.2 tons of iron per sq. ft. of hearth area when we want it, and to obtain it have to blow approximately 170 cu. ft. of air per sq. ft. of hearth area, per minute, to get it. At this rate the 20-foot furnace will produce about 690 tons and the 25-foot furnace 1075 tons per day.

A Member: I am interested in the cold core in the center of the furnace. Is that not a matter of air penetration? What relation does the cold core have to the tonnage of the furnace? If we get a complete penetration we get an entire combustion throughout the bosh of our furnace. If we get our tuyeres off just a little bit we burn a hole in the side of the furnace, which very often happens. I wonder if the cold core in the center of the furnace isn't largely a matter of operation rather than an engineering matter.

In regard to the top of the furnace in relation to the sides of the bosh, I believe the furnace should be somewhat smaller at the top because as your stock comes down it increases in temperature, and if it increases in temperature it expands to a certain extent, and with the air passing through the stock it is liable to clog the stock. Where we have hanging or slipping we have that by reason of the fact our lines are too straight. I feel, as the stock comes down, if it has room to expand we will get better operation.

I wondered if your cold core isn't a matter of operation rather than engineering.

A. G. McKee: I think it has been very fully demonstrated that your oxygen, or your blast, in no case gets more than 24 inches from the nose of the tuyere. Possibly 30 inches. And your carbon dioxide is all reduced to carbon monoxide at a maximum of 40 to 44 inches from the nose of the tuyere. That is contrary to the belief that we have had all of our lives, and the Bureau of Mines have completely demonstrated it to be a fact, no matter how hard you blow the furnace, no matter how much air you put in between the tuyere, you do not exceed those dimensions. It has not only been proven by the Bureau of Mines but also by investigations made in Germany which are quite complete and conclusive. That being the case, I don't think there is much question but what you do actually have a colder core in the center. If the facts as given to us by the Bureau of Mines are established, and are actually facts, then you can't blow air clear into the center of a furnace, particularly if it is a big furnace. And there is no doubt but what the central part of the furnace is inactive in that the blast doesn't keep it stirred up as it does the coke immediately in front of the tuyeres. I think it is contrary to the beliefs many of us have had in years past.

As for the top diameter and slope of the furnace, I think Mr. Riddle will bear me out in my statement that with modern operating conditions you can operate a furnace with entirely successful results if your batter is much less than has been the case in many furnaces where the batter has been 1½-inch, or thereabouts. I think that is a fact, and if we can get any advantage from having a large top and less batter, especially with large diameters, I don't see any reason why we shouldn't go to the large diameters.

Recent Developments In The Welding of Aluminum Alloys

By D. I. BOHN,
Electrical Engineer, Aluminum Company of America, Pittsburgh, Pa.

Paper presented at the A. I. & S. E. E. Annual Convention held in Cleveland, Ohio, September 18, 19 and 20, 1934.

The work of the iron and steel industry not only has been greatly affected by the rapid growth of welding, but in many cases the industry has pioneered these developments which have so entirely altered many forms of fabrication in the last few years. It is only natural to expect that a somewhat parallel development will follow in the aluminum industry as the use grows for these relatively new alloys for transportation, structural and many other applications.

It is only fairly recently that the complexities of special alloy steels have altered the steel industry's picture from a welding standpoint. In the aluminum alloys, however, this condition always has existed because much of the aluminum used depends on the properties obtained through alloying and heat treatment.

Since the average person who has not been associated with the use of aluminum to any great extent thinks of aluminum as merely "aluminum," it might be well to mention briefly the characteristics of a few of these typical alloys, as the entire design of a structure involving welding must be based on a knowledge of the effect of this welding on the alloys employed.

The aluminum alloys may be divided into two general groups. The first group, and the one which constitutes the bulk of the non-structural or semi-structural applications, consists of a number of alloys termed "common" alloys. These alloys receive their properties from the alloying constituents and cold work, no heat treatment being involved.

Commercially pure annealed aluminum of about 99.0% purity has tensile and yield strengths of 13,000 lbs. per square inch and 4000 lbs. per square inch, respectively, whereas one of the common alloys, 52S, in the full hard condition (this being indicated by adding the suffix "H" to the designation 52S) has tensile and yield strengths of 41,000 lbs. per square inch and 35,000 lbs. per square inch, respectively.

In the order of their physical properties this group of alloys consists of 2S, 3S, 4S and 52S.

It will not be the purpose of this paper to go into a full discussion of the other properties, such as elongation, corrosion resistance, and many other properties, as all of this information is available.

The second group of alloys is known as "strong" alloys, and in every case are heat treatable. The various properties are a result of the alloying constituents and heat treatment, and in some cases additional cold work is used to raise the yield point.

In general, each relatively well known alloy of this group has specific properties which permit it to be the most satisfactory for the job in question. The strengths in most cases are well above those of the common alloys, one of the strongest of the commercial alloys of this group being 24ST, having typical tensile and yield strengths of 65,000 lbs. per square inch and 43,000 lbs. per square inch, respectively.

The heat treatment of all of these alloys consists of two stages. The first is the quenching in water (or in some cases air) after the alloy has been maintained at a definite high temperature for a period of time. This quenching does not immediately give the alloy the full eventual high properties, as a further treatment known as "aging" must be permitted or employed. With some of these alloys this aging automatically occurs at room temperature, the maximum strength being reached in three or four days. With certain of the other alloys the process is carried out by maintaining the alloy at a temperature of several hundred degrees for a number of hours.

Duralumin (17ST) probably is the best known of the strong alloys and has been the basis of aircraft construction practically since the industry has extensively used metal. A later alloy, 24ST, has the same general characteristics, but is stronger than 17ST, and is superseding it in many cases. Other high strength alloys include 27ST, which is used extensively for heavy structural work, and 53ST which has relatively good properties and is particularly suitable where severe corrosion conditions exist.

The above discussion may seem somewhat far removed from the discussion of welding, but in reality it is so closely allied that it is almost impossible to make general statements with respect to the "weldability", strengths expected in the welds, ductility of welds, and other properties. It is particularly important that the designer employing welding uses it in such a way that the value of the high strength alloys is not decreased so far as the resultant structure is concerned.

All aluminum welding, regardless of the alloy, must be done with the metal in the molten condition. Practically speaking, the art of hammer welding at a forging temperature has not been developed. It is quite obvious, therefore, that the problems in connection with welding aluminum are radically different than with steel, as a molten alloy possesses no mechanical properties, and the welding method must satisfactorily take care of this fact.

Torch welding has been used with the aluminum alloys nearly since the birth of the industry. It is very extensively used at present, and possesses certain definite advantages for many types of work. A properly made torch weld has reasonably good duc-

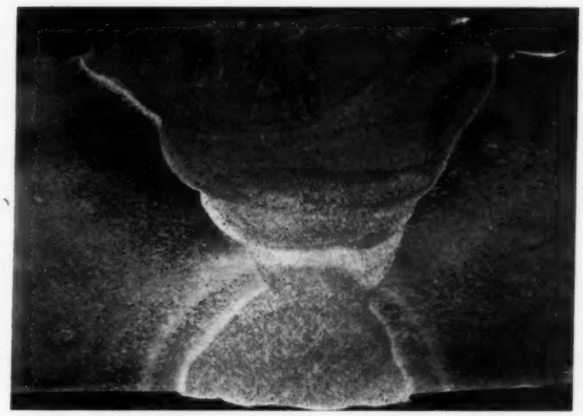


FIG. 1—Metallic arc butt weld between two 27 ST plates 2" thick.

tility, depending on the alloy, practically entire freedom from porosity, and in the hands of a competent operator is a relatively fast operation for some types of work. With certain of the alloys or in cases where distortion is an important factor, the fact that torch welding heats a relatively large volume of metal makes it less satisfactory than some of the more recently developed methods.

This paper will not be concerned with torch welding, but will cover to some extent the more recently developed arc and resistance welding, as the use of these methods is increasing quite rapidly.

Arc Welding

Manual metallic arc welding has been quite commonly employed for the last few years with the aluminum alloys. This is largely because no special equipment other than that used for welding steel normally is required. Practically all of the alloys may be welded satisfactorily in this manner, and since the heating is relatively local the annealed zone is much narrower than when torch welding is employed. The welds are apt to have a certain amount of porosity, but in many applications this is not a serious handicap to its use. The method is more rapid than torch welding, and a few weeks of experience by any competent arc welder will result in a very satisfactory weld.

The rods employed are usually an alloy consisting of commercially pure aluminum and 5% silicon. This combination flows better than pure aluminum alone, has satisfactory strengths for most purposes, and makes unnecessary the use of special alloy rods for most applications. The rods are coated with a flux, this being necessary in all types of fusion welding of the aluminum alloys.

The operation is carried on in a manner quite similar to that used for steel. For a butt weld between two plates up to ⅜" thick, no edge preparation or veeing is used, complete penetration being obtained with one bead. It is necessary to employ a backup strip of copper or steel as, otherwise, if complete penetration is obtained the molten metal will merely fall through.

For heavier gages the edges are vee-ed with about a 60° included angle to within about ¼" of the bottom. Several beads may be employed, and usually the material is turned over and a final single bead done from the back. When each bead is completed the flux must be mechanically removed to prevent inclusions in the final weld.

Figure 1 shows a micrograph of a manual metallic arc weld between two 2" plates of alloy 27ST. The edges in this case were vee-ed to within about ¼" of the bottom and six beads were employed for the main portion of the weld, one bead being made from the back. An ordinary 400 ampere arc welding machine was employed using a ⅜" rod, the current being 550 to 600 amperes.

Since alloy 27ST receives its properties from heat treatment, it is evident that the strength of this weld is less than that of the parent metal. This might easily prevent the use of a weld of this nature for certain applications, but in this particular case the designer so employed his welding that the value of the high strength alloy was not reduced in so far as the completed structure was concerned.

Metallic arc welding is also employed, as with steel, for all types of mechanical joints, it being used for fillet welds, the same as is done with steel. In many cases the heat from the weld does not penetrate far enough into the structural member so as to substantially reduce the properties of the member.

All of the above refers to the use of a standard, direct current, welding motor generator set. For

FIG. 2—Transverse section of a seam weld between two sheets of strong aluminum alloy, thickness .051".

thin sheet, such as ⅛", an AC welder employing high frequency to maintain the arc is somewhat preferable as it is very difficult to maintain the DC arc at extremely low currents.

The manual carbon arc weld also is quite suitable for the lighter gages of material, the carbon being controlled with one hand, the flux coated rod being fed with the other. These welds are remarkably fee from porosity, but require greater skili and are not as conveniently applicable to a great many jobs as is the metallic arc.

Quite a thorough study is being made of the automatic DC carbon arc employing an AC magnetic field. This provides the finest fusion welds which we have encountered, they being free from porosity and of good ductility; and its use is expected to grow in favor for certain production work where an automatic equipment may be used. Obviously, there are a great many types of work which must be done manually, but the specific case of large and small tanks represents one field which we would expect to extensively employ this process.

The actual structure and properties of the weld are practically identical with those of a first-class torch weld, but the annealed zone is much narrower, and the almost complete freedom from distortion

eliminates in many cases the necessity of considering this problem.

Excellent fusion welds have been made with the atomic hydrogen method, both automatic and manual, the weld characteristics being very similar to those obtained from the automatic carbon arc.

All of these arc welding methods are applicable to nearly all of the alloys, the mechanical properties resulting being largely dependent on the alloy employed. Various combinations of filler rod are employed, although in most cases either 2S (commercial aluminum) or the 5% silicon rod may be used.

Spot Welding

As mentioned in connection with arc welding, any commercially welded aluminum requires that the metal be molten at the point of weld. Spot welding is no exception, and the equipment and methods employed must be based on this consideration.

In order that such a condition obtains it is evident that an extremely high thermal gradient must exist from the point of fusion to the external sheet surfaces. If this molten zone of metal is permitted to extend to the outer surface, or very close to it, all mechanical properties are lost, and the electrodes will merely crush through the molten zone. The equipment must be of such a type as to permit a maximum of a few hundred degrees temperature at the outside sheet surfaces and still provide a melting

FIG. 3—Longitudinal section through the same weld shown in Fig. 2.

temperature between the sheets. This means that possibly a thousand degrees or so thermal gradient must exist across the thickness of a sheet.

A suitable spot welding equipment for all of the aluminum alloys should involve the following features:

1. A sufficient welding ampere output for the gage of material being welded.
2. A moving electrode assembly of low inertia.
3. A suitable electrode design.
4. Precision synchronous timing of power application.

The first feature is purely an electrical design problem and demands that the transformer specifications and circuit design, as well as power supply, be such that the desired amperage is available. These values range from about 14,000 amperes to weld two .020" sheets together, to about 35,000 to 38,000 amperes to weld two ⅛" sheets together. These figures are merely approximate, as surface conditions, alloy, and other considerations may vary them appreciably.

Relatively high electrode pressures are employed with the aluminum alloys, depending on the thickness and hardness. The hammer blow resulting from a moving electrode assembly of relatively high inertia is detrimental as it Brinnells the surfaces of the sheets being welded.

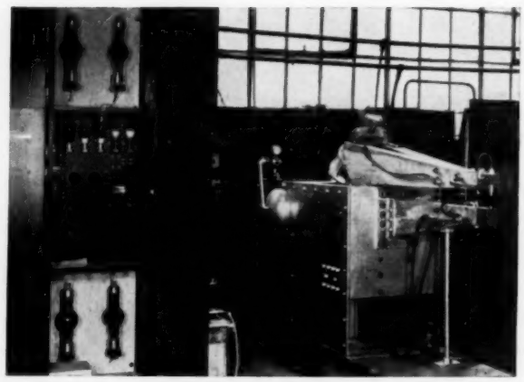


FIG. 4—Special spot welder for aluminum alloys, maximum welding amperes 35,000 equipped with 700 KVA Thyratron control shown at left.

The third consideration, proper electrode design, is a relatively simple problem and has resulted from development work with many types of electrodes. The most satisfactory one which we have employed has a contacting contour consisting of a 7° cone, that is, the included angle is 166°. Two of these conical electrodes normally are employed, although practically equally good results may be obtained if one flat and one conical electrode are used. The latter combination is quite often demanded in order to eliminate the indentation on one of the sheet surfaces which the conical electrode will leave.

The last feature, precise electrical timing, is absolutely essential for consistent results in the thinner gages of the strong alloys, and is desirable for all aluminum alloy spot welding. The use of the electronic timing equipment, which handles directly the primary welder current through mercury tubes, gives an ideal solution for this particular problem. No mechanical switch—synchronous or otherwise—can any more than approach the results which this type of equipment will give.

A proper spot weld will have the molten spheroid extend about one-half to two-thirds of the way toward the outer surfaces of the sheet. For .020" sheets a timing of one cycle (on 60 cycles) gives this condition. The problems involved in attempting to control several hundred KVA this accurately by mechanical means are evident.

The variables which enter into the making of a spot weld are:

(a) Electrode pressure.
(b) Electrode contour.
(c) Surface condition of sheet.
(d) Time of power application.
(e) Amperes.

The only one of the above variables which are not directly externally controllable is with respect to variations in the surface condition of the sheet. With a given group of material, fabricated in the same manner, this surface resistance will be remarkably constant. In addition, a slight compensating effect is produced from the electrode design. The use of the conical contour means that as the molten spheroid increases in size the current density will be decreased as the area of the electrode contacting the

sheet increases. This provides a measure of inherent stability and improves the strength consistency of successive spot welds as compared with other types of electrodes.

Similarly, a few per cent change in line voltage does not greatly affect the consistency of results, and with this proper type of equipment the process is by no means critical.

With practically all of the common alloys the material is spot welded without external cleaning or other treatment. With nearly all of the heat treated alloys it is necessary to remove a high resistance film by sandpapering, where the electrodes contact the sheet.

It is sometimes advisable to sandpaper one of the inside surfaces in order to avoid an explosive effect which occurs when this surface resistance between sheets is too high.

Alclad is a duplex metal consisting of a 5% thickness of pure aluminum on the outside surfaces of a high strength alloy. The difference in electrochemical potential between the alloy and the pure aluminum permits the latter to electrolytically protect the high strength alloy so this material is quite extensively used where corrosion conditions are severe.

Because of the pure aluminum exterior, no surface cleaning or other preparation is necessary with Alclad.

Seam Welding

Seam welding is merely a special adaptation of spot welding. A continuous gas-tight weld between two sheets can be made with a spot welder by making the spot centers close enough together so that they overlap. This is, of course, a very slow process, whereas the same result can be obtained at a relatively high production speed by means of a seam welder.

Any seam welder suitable for steel may be used for aluminum provided the current output is sufficient and if it is provided with synchronous intermittent control. This latter feature is all-important and again the electronic control available fulfills all requirements.

If no intermittent power supply is used, and instead straight AC is applied, the effect is the same as though a too long time is used when spot welding. If sufficient current is applied to cause any melting, the thermal gradient existing from the inside sheet surfaces to the outer is so low that the entire volume of metal between the wheels will be melted. If, however, power is applied intermittently for a relatively small percentage of the time, a continuous seam weld consisting of overlapping spots will be formed, with the molten spheroid extending only one-half to two-thirds of the way toward the outer surfaces, which have remained relatively cool during the operation.

A general rule is to keep the "on" period 25% or less of the total time. For instance, one setting which is used with certain gages of material is one cycle on and three off, although this "on" percentage has been reduced to half of this value in some cases by using one cycle on and seven off.

The speed of operation is governed by these cycle settings and the desired number of impulses per inch of weld. For instance, for .064" material we normally would have ten to twelve spots per inch, and a very satisfactory control setting which has been used for this gage material is two cycles on and seven cycles off.

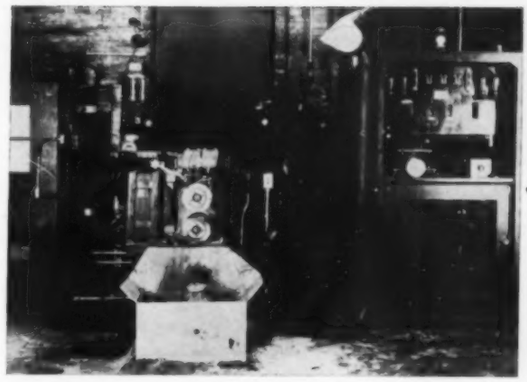


FIG. 5—Special seam welder for aluminum alloys, maximum welding amperes 50,000 equipped with Ignitron control shown on right.

The name "seam welder" normally implies that this equipment is used for making gas-tight or liquid-tight vessels, and this is probably its largest field. No trouble whatever is experienced in making such welds for pressure-tight vessels in production.

There are a great many spot welding operations which can be performed much more easily with a seam welder. In the case of the strong alloys, for instance, if it is desired to run a good many feet of spots spaced quite closely, this may be done on the seam welder by adjusting the "off" period long enough to provide the desired center-to-center spot spacing. The extreme flexibility of the electronic type of control permits changes in these adjustments to be made as desired.

The electrode wheels follow the general design used for spot welding. One of them may have a flat or slightly rounded surface and the other one made with a "V" contour of seven degrees.

Butt Welding

The work of butt welding has not been carried as far as has been done with other methods and its field is somewhat more limited. A butt weld made by any method obviously means that the strength of the entire welded section has been reduced as compared with the parent metal. The architectural field, as well as some others, offers quite a number of possibilities for resistance butt welding.

The conventional method of flash welding as used with steel has not been uniformly successful with aluminum, although more work remains to be done in this direction. The straight resistance method, however, has given excellent results in cases where the sections to be welded are not extremely thin or complicated.

The general method consists of applying pressure by means of an hydraulic or air cylinder, and maintaining it during the operation. Power is applied, and the cutting off of power is governed by pushup, a small control switch being arranged to open the main contactor when a preset fraction of an inch travel has occurred. Synchronous electronic timing is not necessary.

One experimental section, for instance, with an area of 3⅛ sq. in. of duralumin, was excellently butt welded using 6000 lbs. pressure and 90,000 amperes, the time required being about 5 seconds. The weld was made before the material was heat treated, and after being heat treated the weld strength averaged about 45,000 lbs. per sq. in., while that of the parent metal was about 60,000 lbs.

A Statement For 1935

By F. A. MERRICK,
President, Westinghouse Electric & Manufacturing Company

The year 1934 closes as another in which the spring and early summer improvement in most lines of business was followed by the late summer and fall decline in those indices which gauge the standing of industrial activity.

Notwithstanding these recent declines, the fact remains that the year as a whole will show improved returns as compared with 1933. With the many complexities of existing circumstances as to both governmental and business problems, it is too much to expect that the progress toward recovery will be in one unbroken line of steady improvement.

The recently evidenced willingness of Government and business to consolidate their common desire and activities for the promotion of recovery on a realistic basis, is the most favorable augury for progress to that end in the year 1935.

The electrical manufacturing industry has shared in the gains of the past year, but is still operating at a rate little better than half of what could be called normal. During 1935 further improvement is expected.

Merchandising lines should feel the stimulus given to the major appliance items by the continuing successful efforts of the power companies to extend their services in these respects. Department stores and other electrical merchandising outlets are taking an increasing interest in their distributing of electrical appliances. The manufacturers have continually improved and extended their lines of appliances for household uses.

All these efforts have worked together throughout the years of depression so that now the generating stations need only a reasonable improvement in the industrial (particularly the heavy industrial) load to find themselves entering the market for the extensions which have been so notably absent in recent years.

In the meantime, recent improvements in distribution apparatus have been so favorably received that increased sales should be realized in 1935 for this important line of apparatus.

Diesel Electric propulsion equipments in 1934 earned prestige as a factor in certain phases of transportation modernization, and operating cost reduction. There should be an increase in Diesel Electric application in the coming year.

There is well founded expectation that some increase in the demand for electrical apparatus will accrue from naval and other Government building programs.

With all the improvements in prospect it is yet unreasonable to expect that 1935 will fully bridge the gap between depression and recovery; but there is substantial reason for the belief that the groundwork is being laid for a progressive return to prosperous times.

Steel Employment and Payrolls Rise In November

Employment and payrolls of the steel industry in November showed increases over the preceding month, according to a report released by the American Iron and Steel Institute.

The industry employed 381,663 in November, the report showed, compared with 381,431 in October. In November, 1933, 399,569 were employed.

November payrolls totalled $32,937,099, as against $32,723,909 in October and $32,671,986 in November a year ago.

Average number of hours worked per week by employees and average earnings per hour in November were correspondingly greater than in the month before, according to the Institute's report.

Employees averaged 27.6 hours per week during November, contrasted with October's average week of 26.8 hours. Average earnings rose from 72.3 cents per hour in October to 72.9 cents in November. A year ago employees working an average of 29.0 hours per week earned an average of 65.9 cents per hour.

The following table compares employment records of November and October 1934, with November 1933:

	Nov. 1934	Oct. 1934	Nov. 1933
Employees	381,663	381,431	399,569
Payrolls	$32,937,099	$32,723,909	$32,671,986
Hrs. per Week per Employee	27.6	26.8	29.0
Av. Earning per Hour	72.9c	72.3c	65.9c
Operating Rate	27.76	24.59	26.92

HEREWITH in the following six pages is presented editorial views of what happened in steel mill engineering during 1934 as expressed by engineers of the industry and manufacturers servicing the industry.

Transportation

By G. N. HARMON,
Chairman, A. I. & S. E. E. Transportation Committee, and Electrical Supt., Republic Steel Corp., Warren District, Warren, Ohio.

G. N. HARMON

When one thinks of the problems involved throughout the steel mills, the first thought is of the design, installation, operation, and maintenance of the mill, itself. No doubt, this is, and should be, the most important consideration to be given, for, after all, the production of steel is the prime object. There are, however, several other phases of plant engineering incidental to its operation, which, in the end, are of almost equal importance. One of these is expressed by the word "transportation", which, in its simplest definition, means "to carry". A more exact definition for our purpose would be "to economically carry from one place to another". The importance of this subject may be realized if we pause for a moment and call to memory the vast amount of equipment within our steel mills, whose sole object is for the purpose of carrying from one point to another, and, to do this in the most economical manner, is the engineer's problem.

The various instruments of transportation required for handling the materials from the raw state to a finished product are as follows:

Raw Materials

Standard Gage Cars, Tanks, Etc.
Narrow Gage Cars.
Overhead Electric Cranes.
Gantry Type Cranes.
Electric Lines and Conduits.
Motor Trucks.
Ore Bridges.
Transfer Cars of all Types.
Belt Conveyors.
Elevators.
Pipe Lines for handling Air, Water, Gas, Steam, and various Products or By-Products.

Finished and Semi-Finished Materials

All of the above, and in addition:
Locomotive Cranes.
Open Top Ladles of various types.
Mixer Cars.
Roller Tables.
Mono-Rails.
Hand Trucks.
Pushers.
Conveyors.
Electric Trucks and Tractors.
Engine-driven Tractors.
Electric Hoists.

This list is by no means complete, as there may be a number of agencies unfamiliar to the writer, but represents those of an average steel mill. There are often incidents that offer specialized cases, which are beyond the scope of this discussion.

Any one of the above items covers a fairly large field, itself. I believe every one realizes the magnitude of the subject of overhead traveling cranes; almost every single application being a special problem of its own. The subject of electric trucks and tractors, also, is another large field and truly a problem in the modern plant.

The successful operation of a steel mill can be easily affected by the interruption of the flow of materials through the plant. To this end, the engineer is confronted with the problem of design, installation, operation, and maintenance of instruments of transportation "to economically carry from one place to another".

Of these problems, design seems to stand out as the most prominent. By design, we do not mean altogether the mechanical design of the machine or equipment under consideration, but, also, the choice of the correct type for the application. A great deal can be accomplished by a correct choice of equipment with a layout most suitable to perform the task at hand. We feel that great stress should be placed on these two points, for, in their fulfillment, lies the secret of successful operation and economical maintenance. A machine poorly designed or erroneously applied will cause endless trouble, not only to the operation, but to its upkeep cost as well.

After a piece of equipment is properly designed and laid out, the installation is greatly simplified. This point, we feel should be done thoroughly, accurately, and neatly. When we say thoroughly and accurately, no further elaboration is necessary, as this is a self-evident fact. Nothing is more impressive than to go into a plant and see equipment neatly installed. Being neatly installed, will require no additional cost, but will be beneficial to the company. Neat installations will be, more or less, void of dangerous conditions, an aspect which is coming more into consideration every day in our continued efforts to reduce accidents to a minimum.

It is often the case that the operations of the various transportation machines do not come under the supervision of either the plant engineer or the maintenance departments; however, this does not

mean that the problems that arise, due to operating conditions of this equipment, should not be fully considered by them when contemplated changes are made or new ones installed. Frequently, we find in plants, the maintenance departments do have charge of the operation. Examples of this are the crane operators, and, in some cases, tractor operators, and to those who have had this responsibility, nothing need be said relative to the fact that it is indeed a problem.

The last major problem of transportation is that of maintenance. While it is the last to present itself, it is by no means the least. To the maintenance men, our estimate is that a large portion of the work of that department is devoted to some type of transportation equipment. Many of the difficulties of keeping machinery in operating condition can be avoided by proper selection of type, size, and capacities, with due consideration of the service to be performed.

It is not our purpose in this short review to advance any theory or practice relative to the particular solution of any problem of transportation. We have merely endeavored to bring to you, in a brief way, the significance of this subject, in our modern steel mill, and trust that the full realization may be had of its importance "to economically carry from one place to another".

Fork Lift Electric Trucks In Steel Mills

By C. H. MOELLER,
Yale & Towne Mfg. Co., Pittsburgh, Pa.

The pulling type of electric tractor is quite common in the steel industry and is used principally for the hauling of sheets, bars, rods, etc. placed on buggies or trailers from one department to another and eventually, directly into freight cars. In more recent years however, the over-end type of lift truck, equipped with either a ram, forks, adjustable jaws, or a goose-neck crane, is becoming more and more popular.

Ram Trucks have been designed to handle coils of strip steel from a 2500# load up to 8000# loads and are now being used with considerable success. Probably the loading of coiled strip steel into box cars is one of the most important uses for this type of truck. There are several installations in which hot rods are picked up with a ram truck and hauled to a cooling floor and when cooled, picked up again and hauled to picklers.

The fork type of truck was probably first used in loading loose tin plate into box cars. These machines have a capacity of 2500# on forks measuring 26" long with an over-all spread of 24" and were at first equipped with clamps to prevent the tin plate from slipping while in transit. Many changes have been made since these machines were first introduced, both in the bundling of the tin plate as well as in the design and construction of the fork trucks, so that it is not uncommon for a machine to haul two and three bundles weighing approximately 6000# directly into cars and placing each bundle on the floor of the car ready for shipment. It is common practice to load from 39 to 42 bundles per car, per hour.

This type of handling and loading is proving so successful that users and manufacturers of sheet steel are considering a similar method for use on the smaller sizes of sheets, that is, sheets up to 96" long. There are a few automobile manufacturers who now receive sheets, within the limits mentioned, wired to wooden stringers and which are arranged for handling by the fork type of lift truck. A photograph of such a machine is shown herewith. This particular truck has a capacity of 8000# on forks

measuring 36" long and adjustable from 20" up to 48" in width. These forks come down to the floor and are inserted under a bundle of steel; the load then can be picked up by either tilting the upright members or elevating the forks. The standard machine has an overall height of 83" with a maximum lift of 52" from the floor; a backward tilt of 25°, and a forward tilt of 8°; is equipped with three motors, one for driving, one for hoisting and one for tilting, 4 wheel steer and 2 wheel drive.

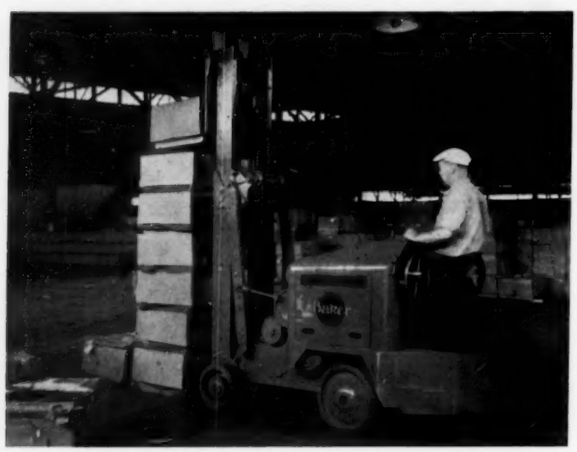
Should high piling or tiering be required, a telescopic or multi-lift mechanism can be incorporated in this model which would give a maximum lift of 102" from the floor without increasing the minimum overall height of the truck itself.

The truck as shown in the photograph is used to supplement the crane service of a large automobile manufacturer in delivering bundles of sheets from storage to forming presses. It is also used for storing sheets in buildings where no crane service exists, as well as performing the functions for which the machine was originally purchased, namely, that of unloading cars. The performance of this truck has been so satisfactory that this same manufacturer has purchased additional equipment of similar design.

New Fork Truck Speeds Operation In Tin Plate Mills

By E. I. WALSH,
Baker-Raulang Company, Cleveland, Ohio.

This new chain lift fork truck was first shown generally at the Iron and Steel Exposition of the A. I. & S. E. E. in September and attracted a great deal of most favorable comment from the executives and operating heads attending the convention.



This truck, known as the type IF, has been given a more or less "streamlined" form in keeping with the modern trend—not, however, for speed but for simplification of design, greater safety for the operator due to the absence of protruding parts on the control end of the truck, and for better appearance. Particular attention has been paid to making the truck most efficient under all operating conditions of picking up, carrying, and stacking packs of tin plate and small cut sheets.

The type IF is made in four models having respective capacities of 4,000, 5,000, 6,000, and 7,000 pounds with a load 30 inches in length, and in an extra large model, known as the IF-70X having a capacity of 7,000 pounds with the load 42" long. It is also furnished as the type IMF which has the tilting feature incorporated allowing the load to be nested securely against the back of the forks to prevent its shifting while travelling over rough floors. Types IFH and IMFH are similar to the types above with the addition of the telescoping feature which permits stacking to extreme heights while still maintaining a low overall height of the truck with the uprights telescoped which permits the truck to clear the standard box car door for loading steel into cars. The forks on all models are adjustable inwards toward the center by means of a crank-operated screw on the carriage.

The frames of all models are one-piece, heavy, rolled, high carbon steel plates extending from the operator's step to the trailing axle with all attachments to the frame being made by driving electrically heated rivets through reamed holes. The uprights are fully machined special channels of alloy steel. The forks are special steel forgings and the fork carriage is amply designed to handle all loads which may be imposed upon it.

The power axle employs the worm drive principle of 17½ to 1 ratio, having a hardened and ground alloy steel worm working on a heavy bronze wheel. The four-pinion differential is mounted in a drop-forged carrier and turns on ball bearings. Axle shafts are of the full-floating type and are of hardened and ground alloy steel as are the universal joints. The joints are enclosed in dust-proof boots.

The suspension of the power axle is Baker's patented Duplex Compensating Suspension wherein all sliding contacts between the axle and the frame are eliminated through the use of two ball-and-socket mounted yokes which take all the driving and braking thrusts and torque and still allow the axle to have free motion in a vertical direction which is absorbed by the rubber pile cushions. These cushions replace the conventional type of springs and consist of piles of alternate rubber and steel discs. As they have to take none of the thrusts or torque, their only function is that of cradling the load and absorbing shocks, and there is no possibility of breakage.

All motors are Baker made and are of the fully enclosed, ball bearing type with high overload capacities. All leads from both the fields and brushes are brought out through the forged field ring by brass binding post studs passing through square breached holes in the ring. This form of construction eliminates broken leads inside the motor case with the consequent costly repair and at the same time permits easy removal of the motor or drive axle for major servicing.

The travel controller is of the Baker continuous torque, metal drum type with large contact surfaces and reversible and renewable electrolytic copper finger tips. Three speeds in both forward and reverse are provided. The lift and tilt controllers are of the same form of construction and are interconnected with the lifting and tilting mechanisms to act as limit switches at both limits of operation. A magnetic blow-out, mill type contactor is interlocked electrically with the brake pedal and the travel controller as a safety switch.

The tilt unit is a triple reduction spur gear unit with the gears running in oil. Pitman or crank wheels are connected to the uprights of the truck by stiff links and provide a forward tilt of 5 degrees and a backward tilt of 20 degrees.

The hoist unit is identical with the tilt unit except that the Pitman wheels are replaced with alloy steel sprockets. The two hoisting chains each have an ultimate strength many times the rated capacity of the truck. All sprockets and fork carriage rollers are mounted on needle bearings which insures the

free movement of the carriage under all loads with the use of a minimum amount of power. The hoisting mechanism is provided with a slack-chain cutout which automatically shuts off the power should the carriage or forks strike an obstruction on the down travel. On lowering under load, the hoist motor is shunted so that it acts as a generator and pumps back into the battery.

Travel speeds under full load and at 36 volts vary on the different models from 3½ to 4¾ miles per hour; travel speeds empty from 4¾ to 6 miles per hour; hoisting speeds under full load, 9 to 13 feet per minute; hoisting speeds empty, 20 to 24 feet per minute; lowering speeds under full load, 20 to 22 feet per minute; lowering speeds empty, 20 feet per minute.

Weights of the models, complete with battery and counterweight, run from 5,975 pounds to 8,300 pounds. Hand wheel steering through appropriate reductions allow the operator to maneuver the truck with ease through congested aisleways and around sharp corners. Battery compartments are designed to accommodate sufficient battery capacity for continuous operation under severe conditions.

The operator's platform is provided with a sponge rubber pad which protects the opertor from excessive vibration on rough roads. Alemite high pressure greasing is provided and all nipples are located for complete accessibility on all units. The grease gun used with this system develops about five times as much pressure as that used with the old system and consequently insures that every part of every bearing is reached and that all the old grease with its embedded dirt is completely forced out.

Cast Roll Progress In 1934

By F. C. T. DANIELS,
Engineer, Research and Development, Mackintosh-Hemphill Co., Pittsburgh, Pa.

The year 1934 is notable for the successful solution of several of the most serious problems that have confronted and handicapped the steel industry. The roll is the true center of action in the production of all rolled shapes, or flat work. The limitations of the mill—of the amount of material rolled—of the quality of surface obtained—are all set by the limitations of the roll itself.

This fact has assumed greater significance during the past few years, which have seen a very material increase in the demands for quality of surface finish on rolled metal products, and a consequent increase in the quality required in the forming rolls themselves. The introduction of new rolling processes—particularly that of the 4-high hot mills for wide strip—has tremendously increased the demands upon the roll. The enormous pressures exerted, and the finish demanded by the trade, necessitate rolls which at the same time have extreme strength to resist breakage, and possess maximum hardness to resist surface marking and produce the bright smooth finish required.

On the other hand, some sheet steel for particular purposes demands a dull or somewhat roughened surface, upon which future processing may be made to adhere. Here a roll of extreme hardness, but with a non-homogeneous structure, is required. Even the blooming or slabbing mill, which first forms the original ingot into slabs to feed the 4-high hot strip mills, demands a better roll than used in previous rolling methods. For it was early discovered that surface markings upon the slabs from the blooming mill were apt to persist through to the finished product.

Today there are available rolls that successfully meet the above demands. They permit the commercial production of a satisfactory product upon the 4-high hot strip mills, with a quality and a surface finish equal to or better than that produced by the old 2-high mill process. The work rolls for the finishing stands are made of a rich alloy chilled cast iron, up to a scleroscope hardness of 90. This is far beyond the limits of machinability, and these rolls must be entirely finished by grinding, for both the smooth and the dull finishing processes.

The problem of the blooming mill rolls has been met by a rich alloy cast steel, made under an entirely new conception of alloy utility. It has eliminated the "fire-cracking" which was formerly believed to be an insurmountable difficulty inherent in steel roughing rolls used in forming hot metal under pressure.

The new type of 3-high hot mills for the rolling of sheets, has presented a different problem to the roll manufacturers. The chilled iron rolls which were tried out first, rapidly broke in service, and it was necessary to resort to a roll of considerably tougher texture. 1934 saw the development of an alloy steel, combining suitable hardness with the finishing qualities demanded by 3-high application.

The "Grain Rolls" of the trade also registered a very decided improvement during 1934. The rolls have now a greater depth of hardness, and a greater strength, thus making them more successful for small shape finishing.

In the finishing of large shapes, a further successful development of the cast alloy steel roll has produced a high-carbon hard alloy steel roll, which is of a uniform texture throughout, and at once free from hard spots, and from spongy areas.

The depression years have—in addition to these specific instances—increased the surface quality demands for almost all other standard rolled steel products. These demands were immediately passed on to the roll manufacturers. They have been met by the general stepping up on the quality of all cast rolls—an increase made possible through the information and knowledge, accumulated by the research and development department of the roll makers, in the manufacture of special rolls for specific heavy-duty purposes.

Revolutionary roll developments have not, during this past year, been confined to the steel industry

alone. Many of the large automobile tire manufacturers, striving to produce a better wearing tire, initiated the practice of using more and faster accelerators in the compounding of the rubber—thus producing a harder and tougher batch. The old type of chilled iron rolls which were formerly used, proved too weak. The roll manufacturers have however developed a cast alloy steel, heat-treated to a hardness closely approaching that of the old chilled iron, which has proved entirely successful. Besides eliminating the breakage, it has permitted considerably increased production in the mills themselves.

In the corrugated rolls—used in the rubber mills for mascerating old rubber tires, or crude rubber—chilled iron has been replaced by an alloy steel roll. The teeth of this roll are locally hardened by the Wearprooft Process, and are proving themselves to possess over ten times the life of the rolls previously used.

Control of Scale Formation In Heating Steel

By T. B. BECHTEL,
The Electric Furnace Company, Salem, Ohio.

Among the most interesting and also among the most important developments in connection with the heating of steel and steel products is the ability to do so in substantial production units with freedom from scale formation.

Bright annealing, as is well known in the cold rolled strip and wire industries, to cite only two well known uses, has been carried on for a long period of time, not always, of course, with the degree of success that might be desired. The development of inexpensive gas atmospheres for bright annealing, while of assistance in these cases, has not been necessary to the operation.

There are, however, many heating and heat treating operations on steel and its products which may, or perhaps must, from the standpoints of uniformity and economy, be carried out continuously. In such operations the development of an inexpensive controlled atmosphere has not only been of assistance but reaches the proportions of an important development.

In many such operations it is not important to bring the work out absolutely bright; in fact, under certain conditions this may be impossible, and in others, though possible, commercially undesirable for reasons of economy. Here the problem is entire elimination of scale. Not only does this apply to continuous operations, but to certain types of batch operations, where it is not possible or perhaps desirable to go to the expense or trouble of tightly sealing the work in a container.

In these several cases, and with the continuous furnace as a good example, since the ends of the furnace must be open to permit the continuous passage of the work into and from the furnace, considerable quantities of the controlled atmosphere medium must be supplied to keep the air out or to reduce the air otherwise entering the furnace. Hence, the importance of an inexpensive controlled atmosphere for this purpose.

During the past year a number of installations have been made in which the products are being turned out either scale-free or bright, depending on the requirements and possibilities of the particular case. Since the problem in each case varies and depends on a number of factors, several of these applications will be touched on separately in the following.

Steel Wire

There has been considerable agitation recently regarding the bright annealing of steel wire. This product affords an excellent example of the feasibility or otherwise of bright annealing. With the soap lubricant generally used by wire mills today, there is not much use of attempting to bright anneal dry drawn wire. A different condition, of course, exists in the case of wet drawing. Furthermore, even if it were possible to bright anneal all wire, total elimination of the cleaning house would still be impossible because of the necessity of pickling the rod.

However, if the wire be kept free from scale, considerable advantages are obtained. Among these is a considerable saving in pickling time, acid consumption and general cost. A better surface condition is obtained which is helpful for work which is redrawn, and of course some metal loss is eliminated. Furthermore, cold acid may be used, which is beneficial to cleaning house operations, and in small mills may permit in summer shutting down a boiler which would otherwise have to be kept fired up under certain conditions of operation.

A recent application in a wire mill in the Middle West includes a controlled atmosphere application to annealing pits. The furnaces are fuel fired, since there is no reason for using electricity in this location, where it would be more expensive, and also since the wire is heated and cooled inside the pots. The pots in this case are of heat-resisting alloy and are light walled, presenting other advantages in addition to those obtained by the use of the controlled atmosphere and as set forth above.

Screw Products

In recent years the tonnage of bolts in the medium carbon range and of various alloys has become of importance. These bolts are used primarily in the automotive and tractor fields and are therefore, for the most part, heat treated to bring out the best physical properties. The heat treatment consists of heating in the range of 1550—1600° F., oil or water quenching and drawing as required, but usually between 800 and 1000° F.

Since a large proportion of these bolts have S. A. E. threads, and the fit or tolerance on this class of product is close, it can readily be appreciated that even small amounts of scale produced in the heat treatment would be embarrassing, not only to the

manufacturer in maintaining gauge and appearance of product, but also on the assembly line, if allowed to go through in the scaled condition.

In this case, the product comes to the furnaces in a condition generally favorable, for the most part, to bright hardening. However, other factors enter into the picture which make it unnecessary or undesirable to go to the extreme of bringing the product out of the hardening furnace in the bright condition. It is, however, important that they be entirely scale-free, as explained above.

Several installations have been made during the past year for this purpose. These units are equipped with a rugged and durable design of belt conveyor and are electrically heated. Electric heat is advantageous in this class of equipment as distinguished from the case of the wire furnaces cited above. The reasons are that the electric furnaces do not require a muffle or retort, as is necessary with the gas fired furnace if results at all comparable are to be obtained. In most cases the cost of retort maintenance will cover the difference in cost between electricity at the usual rates obtainable and even a comparatively cheap fuel such as natural gas. Thus the electric heat in this case has the clear advantage of direct application, together with its usual and inherent ease of application, uniformity of temperature distribution and trouble-free operation.

One of the installations mentioned is shown in the accompanying illustration. (Fig. 1.)

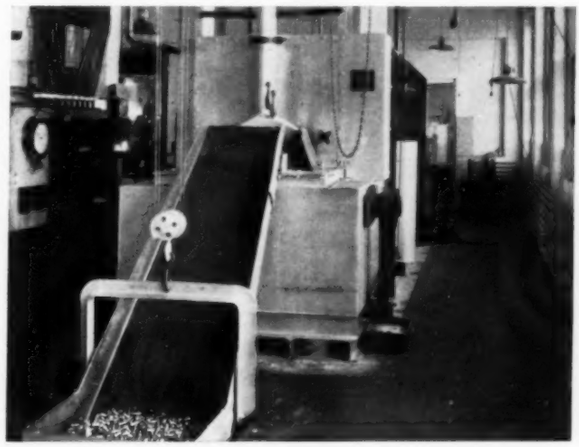


FIG. 1

Steel Stampings

As can be seen in the foregoing discussion of two classes of steel products, the desirability of turning out a product simply free from scale, or entirely free from any discoloration whatever, depends on a number of conditions.

In the case of steel stampings these factors are all important. For example, in an enameling plant, such annealing as is done, in the case of kitchen ware particularly, is practically all process anneal. Since the work comes from the presses with a coating of die lubricant, a really bright annealed piece may be difficult, if not impossible, of attainment. Freedom from scale is important because of its bearing on die life, but discoloration is not important because the steel is all pickled before enameling.

Here a suitably designed gas fired furnace, with proper attention to combustion and control details, will generally prove adequate as to anneal and surface. However, for other classes of stampings it is desirable that a bright or deoxidized surface be produced on the annealed part. This restricts the choice to an electric furnace with controlled atmosphere. In applications such as require a final anneal, or where a continuous controlled atmosphere brazing operation is being applied, pickling after annealing may be dispensed with for certain finishes.

Cold Rolled Strip

Another interesting piece of equipment representing a development of the past year is a continuous furnace for the annealing or perhaps, more properly, the normalizing of cold rolled strip steel.

A furnace for this purpose is shown in Fig. 2.

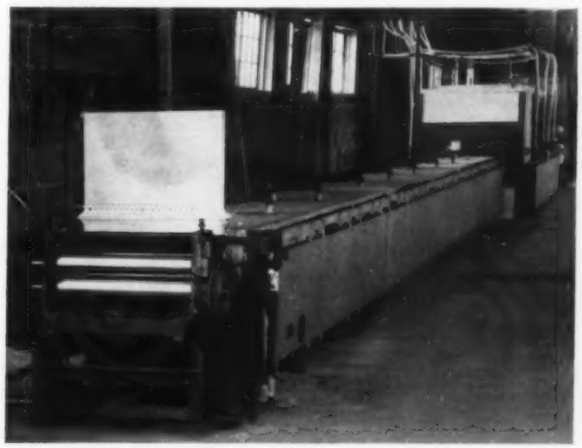


FIG. 2

For the most part, at least as concerns the mill which merchandises strip and does not fabricate the product, it is necessary that the annealed product be free from tarnish and therefore practically in the same condition as when it left the cold mill. This, of course, is with reference to surface finish and not hardness.

Other than roll oil, which is controllable, there is nothing to prevent such condition being attained. As concerns the furnace, it is electrically heated, and due to the size of the retort or muffle which would be necessary were such furnaces to be gas fired, and the problem of maintaining tight joints, etc., it appears that the future of such furnaces is confined largely to electric heat.

The coming year will probably see considerable advances, or at least attempts made toward advancement, in this field.

ELECTRICALLY OPERATED CRANE STATISTICS—1934

ELECTRIC OVERHEAD TRAVELING CRANES, CHARGERS, HOISTS PURCHASED BY IRON AND STEEL INDUSTRY

Table No. 1

Trend of Bearing Construction

Number of Cranes Purchased	Crane Tonnage	Completely Equipped with Anti-Friction Bearings	Partially Equipped	Sleeve Bronze Bearings Etc.
1	1	.....	1	.....
3	3	3	.....	.....
5	5	4	1	.....
1	6	1	.....	.....
2	7½	2	.....	.....
2	10	1	.....	1
19	15	15	2	2
3	20	2	1	.....
2	25	2	.....	.....
1	40	.....	1	.....
1	50	1	.....	.....
5	60	4	.....	1
1	90	.....	.....	1
1	125	.....	.....	1
1	150	1	.....	.....
—	——	—	—	—
48		36	6	6

TROLLEYS PURCHASED

Number of Trolleys Purchased	Tonnage	Completely Equipped with Anti-Friction Bearings	Partially Equipped	Sleeve Bronze Bearings Etc.
4	5	4	.....	.....
2	10	1	.....	1
—	—	—	—	—
6		5		1

Table No. 2

Type of Cranes Purchased

Standard Cranes	35
Double Hook, Double Drum, Three Hook	3
Soaking Pit Crane	1
Stripper and Extractor Crane	1
Coil Handling Crane	1
Machine Shop Crane	1
Roll Shop Crane	1
Special Cranes	5
Total	48

TYPE OF GEARING

Cranes equipped with Spur Gears	25
Spur and Worm Gears	4
Helical Gears	3
Spur and Helical Gears	4
Worm and Helical Gears	2
Spur and Herringbone Gears	9
Worm Gears	1
Total	48

COMPILATION

Total Cranes purchased	48
Cranes completely equipped with Anti-friction Bearings	36
Cranes partially equipped with Anti-friction Bearings	6
Cranes equipped with Sleeve, Bronze Bearings, etc.	6
Total	48
Trolleys Purchased	6
Trolleys completely equipped with Anti-friction Bearings	5
Trolleys equipped with Sleeve, Bronze Bearings, etc.	1
Trolleys equipped with Spur Gears	5
Trolley unclassified as to Gearing	1

182 Motors furnished.

Total Tonnage purchased, 1,226.

37 Cranes used D.C. Current.

11 Cranes used A.C. Current.

Developments In The Iron and Steel Industry During The Year 1934

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The data compiled in this review is taken from the editorial pages of the past twelve issues of the IRON and STEEL ENGINEER. As the code of fair competition governing the iron and steel industry permitted no expansion in pig iron or steel ingot manufacturing capacity, major expenditures of appropriations granted for rehabilitation and new construction projects were apportioned to the finishing departments of the industry.

Blast Furnaces

During the past year one blast furnace was reconstructed and eight stacks were dismantled. Several furnaces were relined and wet washing and electrical precipitating equipment for securing cleaner gas were installed on others.

The trend of thought among the blast operators over the past twelve month period centered on future lines of stacks, particularly top diameters, bosh angles, tuyere construction, hearth diameters and checker work in stoves to secure higher temperatures.

Open Hearths

Relentless efforts were made by the steel industry during 1934 to reduce the appalling waste in the utilization of heat by insulating the checkers, slag pockets, uptakes, flues, port ends, port roofs, front and back walls of open hearth furnaces.

The installation of semi-automatic and automatic combustion control equipment with consequent important secondary results in savings of refractories and repair cost, some averaging better than 10% alone in these two items, received quite a bit of attention from the combustion engineer and the open hearth superintendent.

Rolling Mills

By far the efforts of the steel industries operating executives and engineers during the past year were directed to the rolling units, particularly mills for the production of flat rolled steel.

Cold mills for the rolling of strip, sheets and thin gauge steel for coating were predominant. In the following tables are presented the electrical and mechanical characteristics and estimated annual capacities of several noteworthy installations which began initial operations during 1934.

INLAND STEEL COMPANY, INDIANA HARBOR, IND.

COLD TIN MILLS

ESTIMATED ANNUAL CAPACITY—100,000 TONS

TANDEM COLD MILL

Motor HP.	Speed	Voltage	Current	ROLL DATA Diameter	Length	Type	No. of Stands	Method of Drive
500	400–800	600	DC	18″–49″	42″	4-High	1	Geared
750	400–800	600	DC	18″–49″	42″	4-High	1	Geared
750	400–800	600	DC	18″–49″	42″	4-High	1	Geared
750	400–800	600	DC	18″–49″	42″	4-High	1	Geared
500	400–800	600	DC	18″–49″	42″	4-High	1	Geared
150	225–900	600	DC	Tension Reel				Geared

REVERSING COLD MILL

Non-Driven				5″–34″	38″	4-High	1	Non-Driven
1000	400–800	600	DC	Tension Reels				Geared

MOTOR-GENERATOR DATA

Motor: 1100 KVA., 6600 Volt, 750 R.P.M., 25 Cycle, Synchronous.
Generator: 750 KW., 600 Volt, Direct Current.
Exciter: 40 KW., 250 Volt, Direct Current.

PLANISHING MILLS

150	850	250	DC	18″–39″	42″	4-High	1	Geared
75	300–1200	250	DC	Tension Reel				Geared
150	850	250	DC	18″–39″	42″	4-High	1	Geared
75	300–1200	250	DC	Tension Reel				Geared

JONES AND LAUGHLIN STEEL CORPORATION, ALIQUIPPA, PA.

COLD TIN MILL

ESTIMATED ANNUAL CAPACITY—35,000 TONS

REVERSING COLD MILL

Motor HP.	Speed	Voltage	Current	ROLL DATA Length	ROLL DATA Diameter	Type	No. of Stands	Method of Drive
800	250–750	600	DC	Reel				Geared
1500	100–300	600	DC	16½"–53"	42"	4-High	1	Direct
800	250–750	600	DC	Reel				Geared

MOTOR-GENERATOR DATA

Motor: 2450 H.P., 6600 Volts, 750 R.P.M., Syn., 25 Cycles, 0.8 Power Factor.

Generators	KW.	Voltage
Mill	1250	600
Reel	750	600
Booster	400	300
Exciter	50	250/250

WEIRTON STEEL COMPANY, WEIRTON, W. VA.

COLD TIN MILL

ESTIMATED ANNUAL CAPACITY—120,000 TONS

TANDEM COLD MILL

Motor HP.	Speed	Current	Voltage	ROLL DATA Diameter	ROLL DATA Length	Type	No. of Stands	Method of Drive
600	300–900	250	DC	18"–42"	38"	4-High	1	Geared
600	300–900	250	DC	18"–42"	38"	4-High	1	Geared
600	300–900	250	DC	18"–42"	38"	4-High	1	Geared
600	300–900	250	DC	18"–42"	38"	4-High	1	Geared
150	600–1400	230	DC	Reel				Geared

WHEELING STEEL CORPORATION, YORKVILLE, OHIO

COLD TIN MILL

ESTIMATED ANNUAL CAPACITY—120,000 TONS

TANDEM COLD MILL

Motor HP.	Speed	Voltage	Current	ROLL DATA Diameter	ROLL DATA Length	Type	No. of Stands	Method of Drive
800	600–800	600	DC	18"–39"	42"	4-High	1	Geared
800	600–800	600	DC	18"–39"	42"	4-High	1	Geared
800	600–800	600	DC	18"–39"	42"	4-High	1	Geared
800	600–800	600	DC	18"–39"	42"	4-High	1	Geared
800	600–800	600	DC	18"–39"	42"	4-High	1	Geared
100–150–150	300–450–900	230	DC	Tension Reel				Geared

Other mills for the cold rolling of sheets and strip placed in operation in 1934 were:

1—4-High Single Stand Sheet Mill with rolls 16" and 44" by 84" for cold rolling full finished auto-body stock at the Eastern Rolling Mill Company, Baltimore, Md.

1—4-High Single Stand Strip Mill with rolls 12" and 28" by 30" and one 2-High Skin Pass Mill with rolls 20" by 28" at the Greer Steel Company, Dover, Ohio.

1—4-High Single Stand Strip Mill with rolls 11½" and 25" by 16" and two 2-High Mills with rolls 12" by 10" at the Rotary Electric Steel Company, Detroit, Mich.

1—4-High Single Stand Strip Mill with frictionally driven rolls, 2¼" and 20" by 7½" at the Edi-

son Storage Battery Company, East Orange, N. J.

1—4-High Single Stand Strip Mill with frictionally driven rolls, 3½" and 19" by 7½" at the Crucible Steel Company, Harrison, N. J.

1—4-High Single Stand Strip Mill with frictionally driven rolls, 3" and 24" by 18" at the Elliott Brothers Company, New Castle, Pa.

Two Hot Strip Mills of the single stand reversing type with coilers located in heating chambers were installed during the past year, one a 2-High mill with rolls 21½" by 20" at the McClouth Steel Company, Detroit, Mich., the other, a 4-High mill with rolls 22½" and 44" by 72" at the Youngstown Sheet and Tube Company, Indiana Harbor, Ind.

Major expansion programs began in 1934 and which will be completed this year are complete hot and cold strip departments at the Youngstown Sheet and Tube Company, Youngstown, Ohio; a hot strip mill at the Carnegie Steel Company's McDonald Mills, Youngstown, Ohio, District; a blooming mill, hot and cold strip mills at the Ford Motor Company, Youngstown, Ohio. In the following tables are contained the electrical and mechanical characteristics of the mills purchased with their estimated annual capacities.

FORD MOTOR COMPANY, DETROIT, MICH.

BLOOMING MILL

ESTIMATED ANNUAL CAPACITY—550,000 TONS

Motor HP.	Speed	Voltage	Current	ROLL DATA Diameter	Length	Type	No. of Stands	Method of Drive
7000	50–120	750	DC	44"	96"	2-High	1	Direct

MOTOR-GENERATOR DATA

Motor: 5000 HP., 13,200 Volt, 3 Phase, 60 Cycle, Induction, with Flywheel.
Generator: 2—3000 KW., 750 Volt, Direct Current.

HOT STRIP MILL

ESTIMATED ANNUAL CAPACITY—500,000 TONS

Motor HP.	Speed	Voltage	Current	ROLL DATA Diameter	Length	Type	No. of Stands	Method of Drive
800	600	440	60	24"	56"	SC. BR.	1	Geared
2500	600	13,200	60	42"	96"	2-High	1	Geared
600	400–800	230	DC			Vert. Edger	1	Geared
2500	514	13,200	60	32"	56"	2-High	1	Geared
600	400–800	230	DC			Vert. Edger	1	Geared
2500	514	13,200	60	21"–46"	56"	4-High	1	Geared
150	400–800	230	DC			Vert. Edger	1	Geared
2500	514	13,200	60	21"–46"	56"	4-High	1	Geared
400	300–600	550	DC	24"	56"	SC. BR.	1	Geared
3000	200–400	550	DC	21"–46"	56"	4-High	1	Geared
3000	200–400	550	DC	21"–46"	56"	4-High	1	Geared
3000	200–400	550	DC	21"–46"	56"	4-High	1	Geared
3000	200–400	550	DC	21"–46"	56"	4-High	1	Geared
3000	200–400	550	DC	21"–46"	56"	4-High	1	Geared
2500	150–400	550	DC	21"–46"	56"	4-High	1	Direct

MOTOR-GENERATOR DATA

Generators: 6—1500 KW., 250 Volt Connected in Series.

COLD STRIP MILLS

ESTIMATED ANNUAL CAPACITY—250,000 TONS

Motor HP.	Speed	Voltage	Current	Mill	ROLL DATA Diameter	Length	Type	No. of Stands	Method of Drive
800	225–787	500	DC				Tension Reel		Geared
2000	300–500	500	DC	Reversing Cold Mill	20½"–56"	84"	4-High	1	Geared
800	225–787	500	DC				Tension Reel		Geared

Motor HP.	Speed	Voltage	Current	Mill	ROLL DATA Diameter	Length	Type	No. of Stands	Method of Drive
1500	350–700	550	DC		18″–46″	56″	4-High	1	Geared
1500	350–700	550	DC		18″–46″	56″	4-High	1	Geared
1500	350–700	550	DC	Tandem Cold Mill	18″–46″	56″	4-High	1	Geared
400	300–1050	550	DC		Tension Reel				Geared

MOTOR-GENERATOR DATA

Motor: 2—2100 KVA., 13,200 Volts, 60 Cycle.
Generators: 2—1500 KW., 250 Volts Series Connected for 550 Volts.

YOUNGSTOWN SHEET AND TUBE COMPANY, YOUNGSTOWN, OHIO

HOT STRIP MILL

ESTIMATED ANNUAL CAPACITY—600,000 TONS

Motor HP.	Speed	Voltage	Current	ROLL DATA Diameter	Length	Type	No. of Stands	Method of Drive
1500	270	2200	60	24″	79″	SC. BR.	1	Geared
3000	150	6600	60	36″–49″	96″	4-High	1	Geared
150	450–900	230	DC			Vert. Edging	1	Geared
3000	514	6600	60	24″–49″	79″	4-High	1	Geared
150	450–900	230	DC			Vert. Edging	1	Geared
3000	514	6600	60	24″–49″	79″	4-High	1	Geared
150	450–900	230	DC			Vert. Edging	1	Geared
5000	514	6600	60	24″–49″	79″	4-High	1	Geared
500	150–450	600	DC	24″	79″	SC. BR.	1	Geared
3500	175–350	600	DC	24″–49″	79″	4-High	1	Geared
3500	175–350	600	DC	24″–49″	79″	4-High	1	Geared
3500	175–350	600	DC	24″–49″	79″	4-High	1	Geared
3500	175–350	600	DC	24″–49″	79″	4-High	1	Geared
3500	175–350	600	DC	24″–49″	79″	4-High	1	Geared
3500	175–350	600	DC	24″–49″	79″	4-High	1	Geared

2—MOTOR-GENERATOR SETS

Motors: 2—8500 H.P., 0.8 P.F., 360 R.P.M., 6600 Volts, 60 Cycle.
Generators: 2—3000 KW., 600 Volt, D.C.

COLD STRIP AND SHEET MILLS

ESTIMATED ANNUAL CAPACITY—250,000 TONS

Motor HP.	Speed	Voltage	Current	Mill	ROLL DATA Diameter	Length	Type	No. of Stands	Method of Drive
1250	300–600	600	DC		20½″–49″	75″	4-High	1	Geared
1250	300–600	600	DC	Tandem Cold Mill	20½″–49″	75″	4-High	1	Geared
1250	300–600	600	DC		20½″–49″	75″	4-High	1	Geared
150–225–225	225–900	600	DC				Tension Reel		Geared
1250	300–600	600	DC	Cold Strip Mill	20½″–49″	75″	4-High	1	Geared
150–225	225–900	600	DC				Tension Reel		Geared

MOTOR-GENERATOR SET

Motor: 5600 H.P., 6600 Volts, 450 R.P.M., 60 Cycle.
Generator: 2—2200 KW., 600 Volts, D.C.

1250	300–600	600	DC	Cold Sheet Mill	20½″–49″	90″	4-High	1	Geared

POWER FURNISHED FROM SHOP BUS AT 250 VOLTS

250	500–1000	230	DC	Skin Pass Mill	27″	54″	2-High	1	Geared
60–125	225–900	230	DC				Reel		Geared

MOTOR-GENERATOR SET

Motor: 430 H.P., 2200 Volt, 60 Cycle, 3 Phase, 1175 R.P.M.
Generator: 300 KW., 230 Volt, Direct Current.

Several mills of the three high automatic type are being built for export. This type of mill is reported to be giving good results, particularly when used as a roughing unit in the conventional and semi-automatic two high finishing sheet mills and for both roughing and finishing when rolling stock of 22 gauge or heavier.

Three hot strip mills in the Chicago District were revamped to produce lighter gauge or wider material during the past year. The Illinois Steel Company's 28" Hot Strip Mill at their Gary, Indiana works is being revamped by the substitution of four high stands in the finishing train. The Inland Steel Company's 76" Hot Strip Mill at their Indiana Harbor Works was widened. The Illinois Steel Company placed an additional finishing stand on their 96" Plate strip mill at the South Chicago, Illinois Works to roll light gauge stock for coiling.

Other projects of interest were the electrification of the rod and blooming mills at the Bethlehem Steel Company's, Johnstown, Pa. plant. The Washburn Wire Company, Phillipsdale, Rhode Island, purchased a 34" Blooming Mill and a 10" Merchant Mill.

While the sheet, tin and strip mills were the object of most attention during the past year consumers were demanding closer tolerances on round stocks used in automatic screw machinery, etc. It is predicted that 1935 will see many existing merchant mills revamped in order to produce precision stock.

Electrification of existing mills combined with new construction required 53 motors totaling 98,900 horsepower for main roll drive duty. The characteristics of th motors purchased for this service are presented in the following table.

ELECTRIC MOTORS OVER 300 HORSEPOWER APPLIED TO MAIN ROLL DRIVES IN THE IRON AND STEEL AND ALLIED INDUSTRIES, DURING THE YEAR 1934

No.	H.P.	Speed	Voltage	Freq.	Type of Mill	Method of Drive	Purchaser	Plant Location	Mfgd. By
1	350	350-600	250	DC	Tube Mill	Geared	Timken Steel & Tube Co.	Canton, Ohio	W.
2	400	300–600	550	DC	Hot Strip	Geared	Ford Motor Company	Detroit, Mich.	W.
3	400	300–1050	550	DC	Tension Reel	Geared	Ford Motor Company	Detroit, Mich.	GE.
4	400	600	2200	60	Roughing Zinc	Geared	Ball Brothers Company	Muncie, Ind.	GE.
5	500	150–450	600	DC	Hot Strip	Geared	Youngstown Sheet & Tube Co.	Youngstown, Ohio	W.
6	500	250-750	250	DC	Cold Strip	Geared	Mesta Machine Company	Homestead, Pa.	GE.
7	500	350-700	250	DC	Cold Strip	Geared	Rotary Electric Steel Co.	Detroit, Mich.	GE.
8	500	600	2300	60	Copper Mill	Geared	C. G. Hussey & Co.	Pittsburgh, Pa.	W.
9	600	400–800	230	DC	Hot Strip Edger	Geared	Ford Motor Company	Detroit, Mich.	AC.
10	600	400–800	230	DC	Hot Strip Edger	Geared	Ford Motor Company	Detroit, Mich.	AC.
11	700	514	2200	60	Brass Mill	Geared	American Brass Company	Waterbury, Conn.	GE.
12	800	225–787	500	DC	Cold Strip	Geared	Ford Motor Company	Detroit, Mich.	W.
13	800	225–787	500	DC	Cold Strip	Geared	Ford Motor Company	Detroit, Mich.	W.
14	800	250–750	250	DC	Cold Strip	Geared	Thomas Steel Company	Warren, Ohio	GE.
15	800	600	440	60	Hot Strip	Geared	Ford Motor Company	Detroit, Mich.	AC.
16	800	600–800	600	DC	Cold Strip	Geared	Wheeling Steel Corp.	Yorkville, Ohio	W.
17	800	600–800	600	DC	Cold Strip	Geared	Wheeling Steel Corp.	Yorkville, Ohio	W.
18	800	600–800	600	DC	Cold Strip	Geared	Wheeling Steel Corp.	Yorkville, Ohio	W.
19	800	600–800	600	DC	Cold Strip	Geared	Wheeling Steel Corp.	Yorkville, Ohio	W.
20	800	600–800	600	DC	Cold Strip	Geared	Wheeling Steel Corp.	Yorkville, Ohio	W.
21	1250	300–600	600	DC	Cold Strip	Geared	Youngstown Sheet & Tube Co.	Youngstown, Ohio	W.
22	1250	300–600	600	DC	Cold Strip	Geared	Youngstown Sheet & Tube Co.	Youngstown, Ohio	W.
23	1250	300–600	600	DC	Cold Strip	Geared	Youngstown Sheet & Tube Co.	Youngstown, Ohio	W.
24	1250	300–600	600	DC	Cold Strip	Geared	Youngstown Sheet & Tube Co.	Youngstown, Ohio	W.
25	1250	300–600	600	DC	Cold Strip	Geared	Youngstown Sheet & Tube Co.	Youngstown, Ohio	W.
26	1500	60–120	600	DC	Rev. Billet	Direct	Rotary Electric Steel Co.	Detroit, Mich.	W.
27	1500	350–700	550	DC	Cold Strip	Geared	Ford Motor Company	Detroit, Mich.	GE.
28	1500	350–700	550	DC	Cold Strip	Geared	Ford Motor Company	Detroit, Mich.	GE.
29	1500	350–700	550	DC	Cold Strip	Geared	Ford Motor Company	Detroit, Mich.	GE.
30	1500	500	3000	50	Sheet Mill	Geared	Asano Bussan Kaisha	Japan	GE.
31	2000	175–400	600	DC	Hot Strip	Geared	Illinois Steel Company	Gary, Ind.	GE.
32	2000	300–500	500	DC	Cold Strip	Geared	Ford Motor Company	Detroit, Mich.	W.
33	2500	150–300	550	DC	Hot Strip	Direct	Ford Motor Company	Detroit, Mich.	W.
34	2500	514	13,200	60	Hot Strip	Geared	Ford Motor Company	Detroit, Mich.	AC.
35	2500	514	13,200	60	Hot Strip	Geared	Ford Motor Company	Detroit, Mich.	AC.
36	2500	514	13,200	60	Hot Strip	Geared	Ford Motor Company	Detroit, Mich.	AC.
37	2500	600	13,200	60	Hot Strip	Geared	Ford Motor Company	Detroit, Mich.	AC.
38	3000	150	6600	60	Hot Strip	Geared	Youngstown Sheet & Tube Co.	Youngstown, Ohio	GE.
39	3000	200–400	550	DC	Hot Strip	Geared	Ford Motor Company	Detroit, Mich.	W.
40	3000	200–400	550	DC	Hot Strip	Geared	Ford Motor Company	Detroit, Mich.	W.
41	3000	200–400	550	DC	Hot Strip	Geared	Ford Motor Company	Detroit, Mich.	W.
42	3000	200–400	550	DC	Hot Strip	Geared	Ford Motor Company	Detroit, Mich.	W.
43	3000	365	3000	25	Sheet Mill	Geared	Tata Iron & Steel Co.	Bombay, India	W.
44	3000	514	6600	60	Hot Strip	Geared	Youngstown Sheet & Tube Co.	Youngstown, Ohio	GE.
45	3000	514	6600	60	Hot Strip	Geared	Youngstown Sheet & Tube Co.	Youngstown, Ohio	GE.
46	3500	175–350	600	DC	Hot Strip	Geared	Youngstown Sheet & Tube Co.	Youngstown, Ohio	W.
47	3500	175–350	600	DC	Hot Strip	Geared	Youngstown Sheet & Tube Co.	Youngstown, Ohio	W.
48	3500	175–350	600	DC	Hot Strip	Geared	Youngstown Sheet & Tube Co.	Youngstown, Ohio	W.
49	3500	175–350	600	DC	Hot Strip	Geared	Youngstown Sheet & Tube Co.	Youngstown, Ohio	W.
50	3500	175–350	600	DC	Hot Strip	Geared	Youngstown Sheet & Tube Co.	Youngstown, Ohio	W.
51	3500	175–350	600	DC	Hot Strip	Geared	Youngstown Sheet & Tube Co.	Youngstown, Ohio	W.
52	4000	375	6600	25	Rod Mill	Geared	Bethlehem Steel Company	Johnstown, Pa.	W.
53	7000	50–120	750	DC	Rev. Blooming	Direct	Ford Motor Company	Detroit, Mich.	GE.

FURTHER TREATMENT OF IRON AND STEEL

The intense desire of the iron and steel industry to produce quality products from a physical and surface standpoint was evidenced by the discussions at the technical sessions of the Association of Iron and Steel Electrical Engineers held during the past year.

Paramount interest was displayed in equipments and methods to remove ingot defects and surface scale, applying protective coatings and annealing and normalizing practices.

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ITEMS OF INTEREST

▲

The United States Steel Corporation announces the following changes in personnel: The resignation of C. L. Wood as vice president in charge of sales, in New York. Appointment of Robert Gregg, president of the Tennessee Coal, Iron and Railroad Company to succeed Mr. Wood. J. L. Perry, vice president of the American Steel and Wire Company, Cleveland, has been shifted to the presidency of the Tennessee company in Birmingham. Retirement of J. B. Carse as chairman of the purchasing agents' committee and director of purchases in New York. Charles H. Rhodes of the Illinois Steel Company has been appointed the successor to Mr. Carse.

▲

J. H. Vohr has been appointed superintendent of the new continuous hot strip mill of the Youngstown Sheet and Tube Company at Campbell, Ohio.

▲

E. Koenig has been named the chief engineer, Republic Steel Corporation, Youngstown District.

The Morgan Engineering Company announces the appointment of S. R. Cox, Jr., as Pittsburgh district manager to succeed J. J. McQuillen, who after forty-five years of service with the Company has requested a leave of absence and will probably in the future be located at the home office. Mr. Cox before becoming associated with the Morgan Company was sales engineer for the Hyatt Roller Bearing Company and previous to that was affiliated with the Carnegie Steel Company at Braddock.

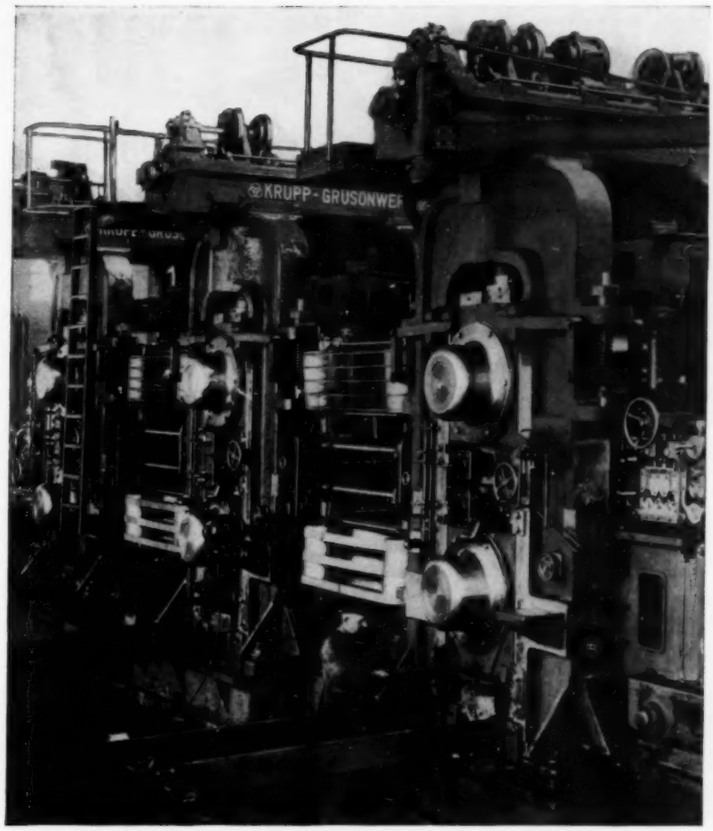
▲

OBITUARIES

David Rees Bowen, vice-president of Farrel-Birmingham Company, Inc., and for forty-five years its chief engineer, died at his home at Ansonia Conn., on Saturday, December 29, 1934.

▲

William W. Macon, for 23 years identified with the editorial department of the Iron Age, during 14 years of that period as managing editor and editor in chief, died January 1 in New York.



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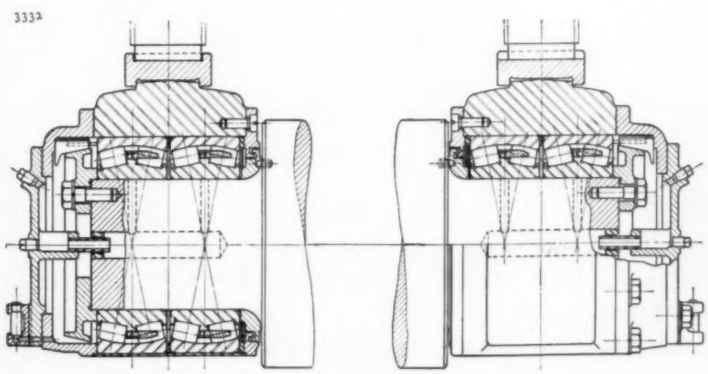

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